**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 9
75 Hawthorne Street
San Francisco, California**

October 18, 2010

Joseph A. Drazek
Quarles & Brady LLP
One Renaissance Square
Two North Central Avenue
Phoenix, AZ 85004-2391

Re: United States Environmental Protection Agency's Statement of Position
Northeast Injection Well Dispute
Phoenix-Goodyear Airport North Superfund Site

Dear Mr. Drazek:

Enclosed is the U.S. Environmental Protection Agency's Statement of Position and exhibits for the above-referenced dispute. Please contact me should you have any questions about any of the documents. Thank you.

Sincerely,

Bethany A. Dreyfus
Assistant Regional Counsel

Enclosures

cc: Henry Friedman, U.S. DOJ
Jane Diamond, EPA
Catherine Brown, EPA
Clancy Tenley, EPA (via email)
David Wood, EPA (via email)
Nicole Coronado, ADEQ
Anthony D. Pantaleoni, Crane Co.
Augustus I. DuPont, Esq., Crane Co. (via email)
Anthony D'Iorio, Crane Co. (via email)

EPA Region IX Dispute Resolution Statement of Position
Phoenix-Goodyear Airport North Superfund Site
October 18, 2010

Introduction

Crane Co. is disputing the U.S. Environmental Protection Agency's (EPA's) requirement to install 2 additional injection wells as part of a hydraulic barrier to prevent the northeast edge of the Phoenix-Goodyear Airport – North Site (PGA-North or Site) contaminated groundwater plume from continuing to move further to the northeast and threatening nearby domestic supply wells. Following significant discussion and evaluation, EPA determined that at least 5 injection wells are necessary to provide confidence that the contamination will not reach beyond its current extent.

This formal dispute arises under Paragraph 88 of the April 2006 Partial Consent Decree (2006 CD) for "disputes pertaining to the selection or adequacy of any response action." (2006 CD ¶88). Pursuant to Paragraph 88.d., Crane Co. has the high burden of demonstrating that EPA's decision was "arbitrary and capricious or otherwise not in accordance with law." Crane Co. invoked Informal Dispute under the 2006 CD regarding the injection wells on July 20, 2010. The Informal Dispute period was extended and ended on September 10, 2010. Crane Co. submitted its Statement of Position (Crane Co. Statement) for formal dispute on September 27, 2010. Pursuant to Paragraph 88a, EPA has established an administrative record for this dispute and has included Crane Co.'s September 27th Statement and supporting documentation.

In its September 27 Statement, Crane Co. asserts that the requirement to install an additional 2 injection wells beyond the 2 currently constructed and 1 planned for installation is not technically justified and is arbitrary. To the contrary, EPA's evaluation of the northeast plume and the remedy in place to address it shows that these 5 injection wells are the minimum necessary to ensure an effective hydraulic barrier.

EPA based its determination that 5 injection wells are necessary using both theoretical calculations and field data, as well as basic injection system design considerations. The radius of influence of 3 injection wells will not be large enough to cover the large distances between these wells; the additional 2 wells requested are spaced between the 3 in place to provide the injection system with denser well coverage over the same distance. Additionally, the injection system must be designed with adequate flexibility to respond to the various influences on groundwater flow in this area and to allow for anticipated system maintenance; using 5 wells can allow for that flexibility. Finally, due to the history of plume growth and the sensitive resources just beyond the plume's current extent, it is vital to be conservative in order to assure that the plume does not continue to expand.

EPA is particularly concerned about protection of this northeast area because the domestic water supplies for two cities lie within a short distance of northern and eastern edges of the plume. A conservative and aggressive approach is necessary to ensure that these nearby water supplies are not threatened. Also, adequate containment of the plume is necessary to effectively conduct aquifer restoration, the final goal of the remedy. EPA must have confidence that the injection system installed will be effective, and at least 5 wells are necessary to provide EPA with that confidence.

PGA-North Northeast Contamination

The injection system at issue is part of a strategy to halt further migration of the PGA-North groundwater contamination to the northeast, where significant domestic water supply wells are located. EPA selected the PGA groundwater remedy in 1989; the remedy requires both containment of the groundwater contamination, primarily trichloroethylene (TCE) and restoration of the aquifers impacted by Site sources (1989 Record of Decision (1989 ROD)). The Site remedy was selected to ensure that contamination did not impact previously uncontaminated areas and to expedite restoration of the aquifer for availability for its highest use, domestic water supply. The cleanup level for TCE in the 1989 ROD is the maximum contaminant level (MCL) under the Safe Drinking Water Act of 5 parts per billion (ppb), as required by Comprehensive Environmental Response, Compensation and Liability Act, as amended (CERCLA), Section 121(d)(2)(A)(i), 42 U.S.C. §9621(d)(2)(A)(i) ("remedial actions shall meet all applicable or relevant and appropriate requirements (ARARs)"), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. 300.430(e)(2)(i)(B), and Arizona law, Arizona Revised Statutes 49-224. (1989 ROD, 2-25). In the Site source area, TCE levels were at 6,000 ppb TCE in one well in June 2010 (MW-07, June 26, 2010) and 1,700 ppb TCE in another well measured in August 2010 (MW-12, August 2010), both hundreds of times the MCL. (Attachment 1: Subunit A TCE Concentrations Second Quarter 2010).

At the time of the 1989 ROD, the Site's TCE plume did not extend far beyond the source area. (Attachment 2: Proposed Remaining Monitor Wells for Subunit A). By the mid-2000s, however, the northern extent of the groundwater plume had avoided capture, travelled miles beyond the source area, and was not adequately characterized. (Attachment 3: Attachments C-1 and C-2 to Appendix C Scope of Work to 2006 CD).

The 2006 CD required installation of priority investigation wells, including wells to delineate the northeast plume. (See Attachment 3). To address the large number of data gaps in a short timeframe, EPA and Crane Co. created a list of priority investigation wells to be drilled during the first 2 years of supplemental investigation. (See Attachment 3, C-1) Wells sited in areas beyond the understood boundary of the plume were to serve as sentinel wells to alert EPA and Crane Co. should the plume expand. Following installation of these wells, a next stage of investigation would be developed to complete plume characterization.[1]

So little was known about the northeast extent of the plume in 2005 that the first phase of wells included only 2 monitor wells for the entire area. One of the 2 wells – MW-16A - was immediately inadequate to act as a sentinel well because it contained 67 ppb of TCE, well over the Site TCE cleanup level of 5 ppb, when it was drilled in 2006. Over the following years, the plume has continued to grow in the northeast, with high levels of TCE in MW-16A reaching 260 ppb in June 2008. "Step-out wells" have continually had to be drilled further outward from the plume center to follow the leading edge of the plume. For instance, when Monitor Well MW-30A was installed in 2007, it was located beyond the 5 ppb plume boundary, showing only 1-2 ppb of TCE. Most recently, however, MW-30A tested at over 30ppb of TCE and is now an interior monitor well. (See Attachment 1).

To date, despite the installation of 9 Subunit A wells in the northeast, that portion of the plume is still not fully defined. While 6 more monitoring wells will be installed in the northeast over the next year, the Site remedy is simultaneously being employed to stop further plume expansion. Two extraction systems – one in the north and one in the east of the plume – were installed in 2007 and 2008. By 2009, however, it was clear that the plume had continued to grow and these new systems were not capable of capturing its far reaches. Importantly, the contamination now extends farther toward production wells for the cities of Goodyear, Avondale, and Litchfield Park.[2] (See Attachments 1 and 2) These cities' water supplies serve over 40,000 households. The eastern boundary of the plume is now within ½ mile of LPSCO-34C, a production well that serves both the cities of Avondale and Goodyear. (*Id.*).

Although the plume at issue here is in Subunit A of the aquifer, there are wells throughout this area that can act as conduits, allowing Subunit A contamination to quickly reach Subunit C, the drinking water aquifer.[3] While numerous evaluations of conduit wells in the area have been performed within the current plume footprint, one cannot rule out the possibility of wells beyond the current plume boundary that could act as conduits for the vertical migration of Site contaminants into Subunit C.

[1] The Priority List of Wells identified timeframes for well drilling: the first set of wells was to be drilled in the first year and the second set in the second year. However, the process has taken far longer than scheduled, and Crane Co. completed the first set of wells in September 2007 and the second set in April 2009, 3 years after signature of the 2006 CD.

[2] Over the years, Site contamination has already forced the closure of 4 municipal supply wells (COG-02, COG-04, COG-10, and GDW), and 10 irrigation wells (G-01, G-02, G-04, 33A, 33C, PSIW, SunCor 3B, Suncor 27C, Suncor 34B, and Goodyear Farms Irrigation Well).

[3] Many production wells in this area are older irrigation wells that were completed in multiple aquifers. Common drilling practices for irrigation wells, some of which are now used as domestic water supply in the area, have open intervals within permeable zones throughout the total depth of the well.

After 5 years of investigation and increased remedial activity, EPA determined that additional efforts, including installation of a third extraction system in the northeast and creation of a hydraulic barrier, were necessary to ensure that the plume does not move any further. Crane Co. asserts that EPA has based its decision on pressure from the 3 cities whose domestic water supply is threatened by the PGA-North plume. (Crane Co. Statement, page ES-1). Because Site contamination impacts water resources in the areas used by these municipalities for their domestic water supplies, the cities have appropriately played a role in technical discussions regarding the cleanup.

Regardless of the cities' input, however, it is EPA's mission to protect human health and the environment "in part by restoring contaminated groundwater to beneficial use." (June 26, 2009 OSWER Directive 9283.1-33: Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration). The 1989 ROD is consistent with EPA policy that requires that "groundwater contamination should not be allowed to migrate and further contaminate the aquifer..." (*Id.*). Importantly, CERCLA Section 118 emphasizes addressing contamination that has already impacted drinking water resources by requiring that "the President ... give a high priority to facilities where the release of hazardous substances or pollutants or contaminants has resulted in the closing of drinking water wells or has contaminated a principal drinking water supply." CERCLA Section 118, 42 U.S.C. §9618. EPA's determination that it is time to aggressively address the northeast portion of this plume is consistent with the 1989 ROD and EPA policy and, as is demonstrated herein, is based on sound technical judgment.

Injection Systems

Containment of contaminated groundwater can be enhanced utilizing an extraction system in combination with a hydraulic barrier to keep contamination from expanding beyond a certain area. An injection system downgradient of a contaminated plume injects clean water into the aquifer, increasing the hydraulic gradient, thereby preventing the plume from continuing movement in that direction.[4] Not only can an injection system create a hydraulic wall, but it can optimize cleanup by directing contamination back toward the extraction wells for treatment; treatment of contaminated groundwater within a smaller area yields a more efficient and effective remedy.[5] Additionally, with a grouping of injection wells, the flow from each well can be adjusted to address flow direction shifts in the future, which is particularly important in this area with a variety of influences on the plume including changing regional pumping patterns and

[4] "Pump-and-Treat Ground-Water Remediation: A Guide for Decision Makers and Practitioners" (USEPA, 1996).

[5] As asserted in its Statement, Crane Co. has had to add numerous wells to the remedy at PGA-North over the past five years. This has been a consequence, however, of addressing a plume that now covers a significantly larger area than anticipated by the original remedy. As a matter of course, it is far less efficient and more costly to treat groundwater contamination at its periphery than close to the source area.

shifting seasonal flow influences. Finally, reinjection of treated groundwater is consistent with the end use requirements of the Site remedy.[6]

Specific Injection Well Requirement for Northeast Area:

Hydraulic containment in the northeast area will serve as a critical component of the remedy to protect public water supplies and the regional aquifer, requiring a particularly robust injection system. Because of potential for further migration to the east based on past and current groundwater gradients and assessment of chemical data, reinjection was proposed in a line for the entire eastern and northern plume boundaries. These injection wells could be used concurrently or managed to be available in different areas of the plume boundary depending on the prevalent groundwater flow direction.

Discussion regarding the appropriate number of injection wells to produce a sufficient barrier has been ongoing since 2009.[7] EPA carefully calculated the appropriate number of injection wells using standard ground-water techniques, including aquifer tests, equations on well hydraulics, and ground-water flow models. These methods also allow us to estimate the future performance of injection wells and the resulting ground-water flow patterns.

By April 2010, EPA had determined that 5 wells were required as a minimum to achieve hydraulic containment. By June 2010 Crane Co. had already installed the injection system pipeline and 2 injection wells along that pipeline. Additionally, Crane Co. included 3 "stub-outs," locations in the system piping where injection wells could be sited at a later time. One injection well at the middle stub-out is already planned for construction. Attached is a map showing the locations of the existing and planned injection wells (IA-11, IA-12, and IA-13) and the stub-out locations for the additional 2 requested injection wells (IA-14 and IA-15). (Attachment 4: Proposed Injection Well Locations). It is the installation of the final 2 injection wells (IA-14 and IA-15) that Crane Co. is objecting to in this dispute.

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[6] May 1993 Explanation of Significant Differences (ESD) #2 to the 1989 ROD.

[7] In May 2009, Crane Co. proposed utilizing a single injection well in conjunction with EA-07, while EPA's original comment was that 7 injection sites along Dysart Road would be appropriate. However, Crane Co.'s July 2009 deliverable again proposed only 1 injection well arguing that the Site model showed that EA-07 could achieve full capture in the northeast. Technical discussions continued, but in order to ensure that an injection system wasn't too far delayed, in September 2009, EPA required that Crane Co. separate out the piping portion of the expansion to the groundwater treatment system to approve separately from the full groundwater treatment system expansion work plan, to allow that portion of construction to move forward and not interfere with startup of the new extraction system. Crane Co. installed piping of a sufficient diameter to carry the maximum build out treatment capacity of the EA-06 treatment system and installed stub-outs for future expansion of injection and extraction along the pipeline.

Why Five Injection Wells: A hydraulic barrier is only successful if the injected water creates overlapping mounding or does not have gaps where contamination can move past the injection points. Thus, a key component in injection system design is proper well spacing to ensure complete containment; the injection wells must be spaced such that the adjacent radii of influence of the wells overlap. When designing an injection system, hydraulic conditions can be estimated from aquifer tests using well-hydraulics equations and ground-water flow models (Cohen et al, 1997). These methods allow prediction of the future hydraulic head (ie., mounding within the water table due to injection) and ground-water flow patterns from the injection wells in order to optimize injection rates, determine injection duration, and site additional wells. EPA performed these analyses for IA-11 and IA-12 at three times: prior to the start of injection (Attachment 5: ITSI, 2010a); following the first week of injection (Attachment 6: ITSI, 2010b); and during operation of IA-11 and IA-12 since their installation. (Attachment 7: ITSI, 2010c) EPA's analyses confirm that the radius of influence of 3 injection wells is insufficient to cover the full 5,500 foot boundary in the northeast.

EPA has used a groundwater flow assessment (Attachment 8: CH2M Hill 2010), a hydraulic gradient/flow vector and injection well mounding analysis (See Attachment 5), along with the above-referenced projected radius of influence for injection well IA-12 (See Attachment 6) and evaluation of injection well testing data from injection wells IA-11 and IA-12 (See Attachment 7) to determine that 3 injection wells would leave significant gaps through which contamination could travel. The 2 gaps between the 3 injection wells are 2,900 and 2,600 feet. Applying data gathered through October 1, 2010 from the 2 existing injection wells, EPA has confirmed that the zones of influence for injection wells in this area are not be capable of filling in these gaps.

EPA used the Thiem equation[8] to project zones of influence for the injection wells. (See Attachment 5) EPA first populated the Thiem equation with data collected from the initial injection testing of IA-12 from August 17 to 20, 2010, using water-level effects in nearby piezometers PZ-11 and PZ-12 and monitoring wells. (See Attachment 6) This evaluation showed that the projected radius of influence for the new injection well, IA-12, assuming injection rates of between 250 to 525 gallons per minute (gpm) and defining the radius of influence as one-foot of water rise, would be approximately 700 to 900 feet. Similar calculations showed that a radius of influence, using 1/2 foot of water rise at an injection rate of 525 gpm, would only increase to approximately 1,100 feet. Similarly, IA-11 was analyzed based on the groundwater mounding data collected during the first 24-hour injection test; IA-11 showed higher mounding than at IA-12, indicating that IA-11 will likely have an even smaller radius of influence than IA-12. EPA's projections were again confirmed through analysis of data gathered 6 weeks following the startup of the 2 injection wells. (See Attachment 7) These degrees of

[8] Ferris, J.G., Knowles, D.B., Brown, R.H., and Stallman, R.W., 1962. Theory of Aquifer Tests - Ground-Water Hydraulics. U.S. Geological Survey Water Supply Paper 1536-E. U.S. Geological Survey, Washington, D.C.

hydraulic mounding would be insufficient to create a full hydraulic barrier between distances of 2,600 to 2,900 feet. Using basic principles of well hydraulics and groundwater flow, there is also no support for Crane Co.'s contention that the mounding effects demonstrated during this testing will expand significantly over long-term operations of the injection wells.

Regional influences on plume control: The design of this injection system must account for the complicating effects of nearby production wells – both irrigation and public water supply – on the groundwater flow regime. Data collected since 2006 and the shape of the plume over time have indicated that groundwater flow directions change seasonally and in response to regional pumping. Accordingly, an injection system must be designed to adapt to groundwater flow changes.

Groundwater flow direction in the northern extent of the plume has consistently remained towards the north/northeast. However, Subunit A groundwater flow direction can shift, as was evidenced in early 2010, when the northern region of the plume shifted toward the northwest. This shift was indicated by the unusually large water level increases in 3 monitoring wells on the plume's eastern edge. Although Crane Co. asserts that this shift is due to the operation of EA-05 and EA-06, other influences also played a part, including: a) short-term pumping decreases of nearby public water supply wells and overall reductions in regional pumping, b) increased recharge from the January 2010 flooding event in the Agua Fria River, and c) potential increased water levels from induced infiltration at the Avondale Wetlands recharge site. Although groundwater levels in the 3 eastern monitoring wells (MW-35A, MW-45A, and MW-39A) peaked in early summer 2010, they have steadily decreased since July 2010, indicating that the northwest shift in groundwater flow is likely temporary.

In order to fully prevent migration on the eastern and north eastern plume boundary, the reinjection system's design must be both robust and flexible to ensure that the barrier operates successfully under the full range of conditions. With a larger number of injection wells, the system can be better modified to respond to changes in flow and other influences on the aquifer.

General Design Guidance: Along with estimates of zones of influence and regional groundwater influences, EPA guidance for the design of injection systems recommends use of more wells in order to account for the loss of system capacity which is common in such systems. Fluid injection is susceptible to permeability reduction due to clogging of the injection well screen openings, which can cause a decline in injection rates.[9] Clogging can result from a combination of physical, chemical, and biological processes. Accordingly, the guidance suggests that injection capacity of a remedial system should be overdesigned with one and a half

[9] Cohen, R.M, Mercer, J.W., Greenwald, R.M., and Beljin, M.S., 1997. Design Guidelines for Conventional Pump-and-Treat Systems. Ground Water Issue, USEPA, Office of Research and Development, EPA/540/S-97/504.

to two times the number of wells required to account for loss of capacity due to permeability reduction and the temporary loss of capacity during well maintenance.[10]

Inadequacy of the Model to Allow for Rapid Response: Crane Co.'s Statement claims that it "currently has a very good definition of the overall extent of the Subunit A and C plumes," and that it has the information to respond rapidly should groundwater conditions change. Crane Co. (Crane Co. Statement at 1-2). These arguments rely on the still unfinished groundwater flow model for the Site. Although there have been significant efforts to complete the model to help predict flow direction and contaminant travel at the Site, to date there is still not sufficient information to populate the model and make it reliable for predicting the impacts of additional extraction or injection wells at this point. Because many of the Subunit A monitoring wells were only installed within the past few years, there is a limited historic water-level and water-quality database to populate the model. This is even more so for Subunit C, where the monitoring network of the northern plume area is comprised of only 7 monitoring wells scattered over roughly 2 square miles. Therefore, any prediction based on the Site-specific model is limited, and any action taken at this point must be conservative to ensure that the remediation installed is effective.

Timing: Crane Co. argues that EPA should defer its determination of the number of injection wells necessary for the hydraulic barrier until more data is obtained following the operation of EA-07 and 3 of the injection wells. Due to its placement within the interior of the plume, it is clear that EA-07 itself will not be capable of capturing the plume's leading edge. EPA's analysis using the current data from injection tests 1 and 6 weeks following the start-up of the first 2 injection wells shows that 3 injection wells will not be able to create a sufficient hydraulic barrier. Even if data in the coming months were to show that there was not plume movement beyond the injection system, this would not necessarily tell us whether the barrier would be sufficient when the groundwater flow shifts further to the north or the east. Finally, as was learned from the experience with EA-05 and EA-06, obtaining the necessary information to determine whether the remedy is functioning sufficiently can take a long time - and the risk is that, during that time, contamination could pass beyond the barrier, rendering it ineffective and threatening more domestic supply wells.

Conclusion

EPA's analysis concluded that 3 injection wells will not reliably contain the northeast plume over time. Five injection wells will improve potential plume containment, but that number may not even completely eliminate the hydraulic gaps. Continued data gathering and analysis is necessary to determine whether additional injection wells – beyond the 5 required now - will be essential to maintain full hydraulic control of the plume in the northeast area.

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[10] *Id.*

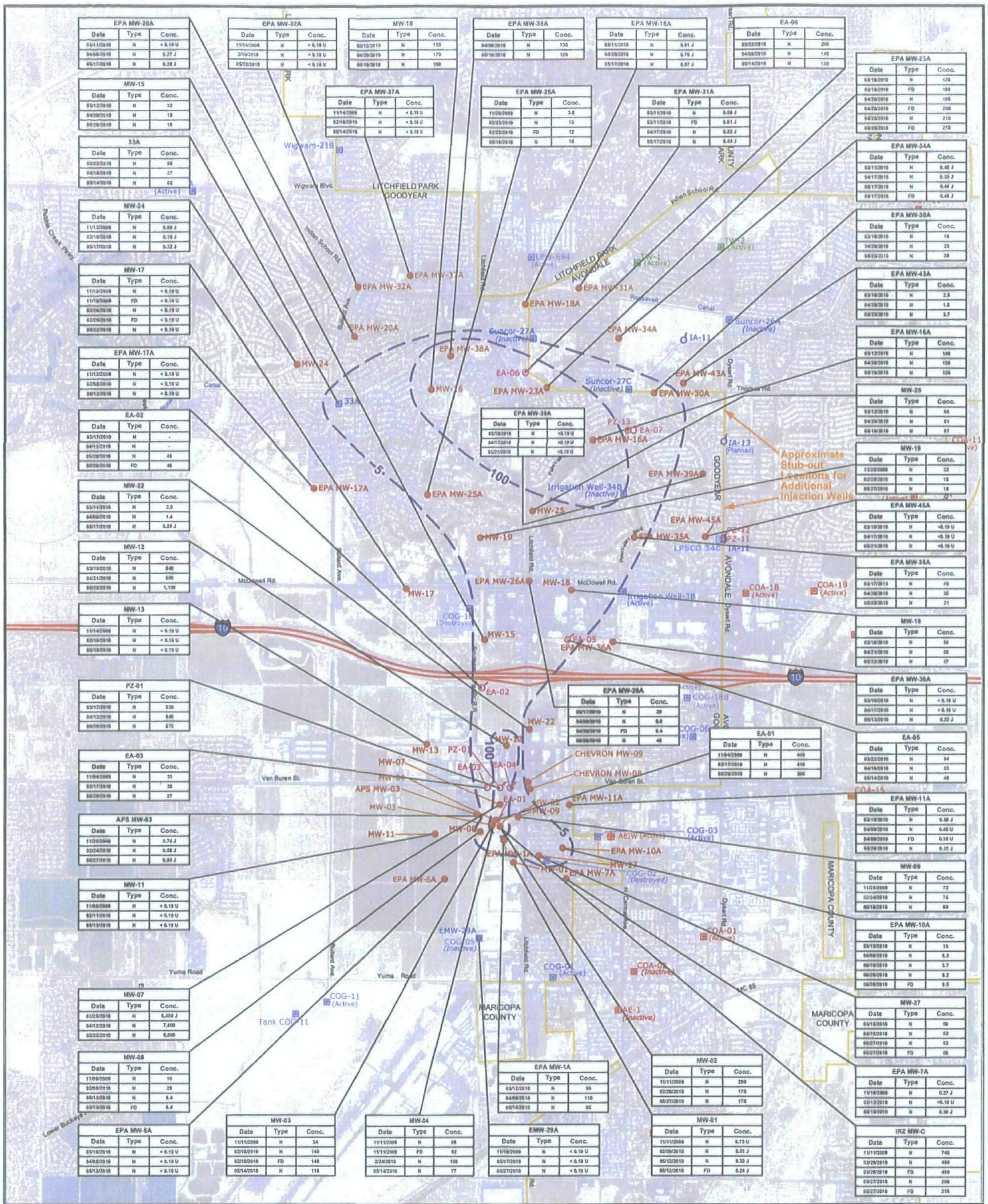
At this juncture, EPA requires an aggressive approach to ensure that the groundwater remedy at PGA-North is protective of human health and the environment. It has been over 20 years since the adoption of the PGA ROD, and use of an incremental approach to remediation has allowed the PGA-North plume to migrate miles from the source area and threaten nearby water supplies, and the contaminated plume now reaches within one-half mile of drinking water supply wells. This project cannot afford to use a "wait-and-see" approach toward plume expansion, and efforts must be focused on stopping further movement of the plume and working to restore the impacted aquifer.

EPA Region IX Dispute Resolution Statement of Position
Phoenix-Goodyear Airport North Superfund Site
October 18, 2010

Attachments

Attachment 1:	CH2M Hill PGA-North Site Map: Subunit A TCE Levels, Second Quarter 2010
Attachment 2:	AMEC Geomatrix PGA-North Site Map: Proposed Remaining Monitor Wells for Subunit A
Attachment 3:	2006 Partial Consent Decree Appendix C, Scope of Work with Attachments C-1 and C2
Attachment 4:	CH2M Hill PGA-North Site Map: Proposed Injection Well Locations
Attachment 5:	ITSI Memorandum, August 24, 2010: Hydraulic Gradient/Flow Vector Evaluation and Hydraulic Mounding Analysis for Inection Wells (IA-11, IA-12, IA-13, IA-14, IA-15, and IA-10) at the Phoenix-Goodyear Airport North (PGAN) Superfund, Goodyear, Arizona (ITSI 2010d)
Attachment 6:	ITSI Memorandum, August 30, 2010: Radius of Influence Analysis for Injection IA-12 at the Phoenix-Goodyear Airport North (PGAN) Superfund, Goodyear, Arizona (ITSI 2010b)
Attachment 7:	ITSI Memorandum, October 13, 2010: Evaluation of Injection Testing Data from Injection Wells IA-11 and IA-12, at the Phoenix-Goodyear Airport North (PGAN) Superfund, Goodyear, Arizona (ITSI 2010c)
Attachment 8:	CH2M Hill Memorandum, August 23, 2010: Uncertainties in Future Consistency for Groundwater Flow Direction in the Northeast Plume, Phoenix-Goodyear Airport-North Superfund Site, Goodyear, Arizona (CH2M Hill 2010)

Attachment I



Explanation

- EPA MW-45A — Subunit A Monitor Well
- EA-06 — Subunit A Extraction Well
- EMW-29A — Subunit A Monitor Well - PGA South Site
- COA MW1 — Subunit A Monitor Well Western Ave. Plume Site
- PZ-10 — Piezometer
- IRZ IW-01 — Injection well (IRZ)
- COA-18 — City of Avondale Supply Well
- 33A — SunCor / UPI Treatment System Well
- Suncor-27C — Palm Valley / SunCor Irrigation Well
- LPSCO-34C — Litchfield Park Services Co. Production Well
- TW-1 — Algonquin Water Services Well
- U — The analyte was analyzed for, but was not detected above the reported sample quantitative limit
- J — The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
- N — Normal sample
- FD — Field duplicate
- — 100 — Isocontour showing TCE concentration in µg/L
- \- — TCE not analyzed

Adapted from:

Approximate scale in feet: 0, 1250, 2500

Approximate scale in meters: 0, 375, 750

EXTRACTION RATE SUMMARY
SECOND QUARTER 2010

WELL	PUMP RATE (gpm)
EA-01	72
EA-02	42
EA-03	78
EA-05	524
EA-06	520
EB-01	30
EC-01	129
MW-20	56
PZ-01	79
33A	693

The extraction rate shown was the average rate based on readings from March 3, 2010 to May 26, 2010.

Note:

TCE concentrations, in micrograms per liter (ug/L), reported from May 2010 sampling.

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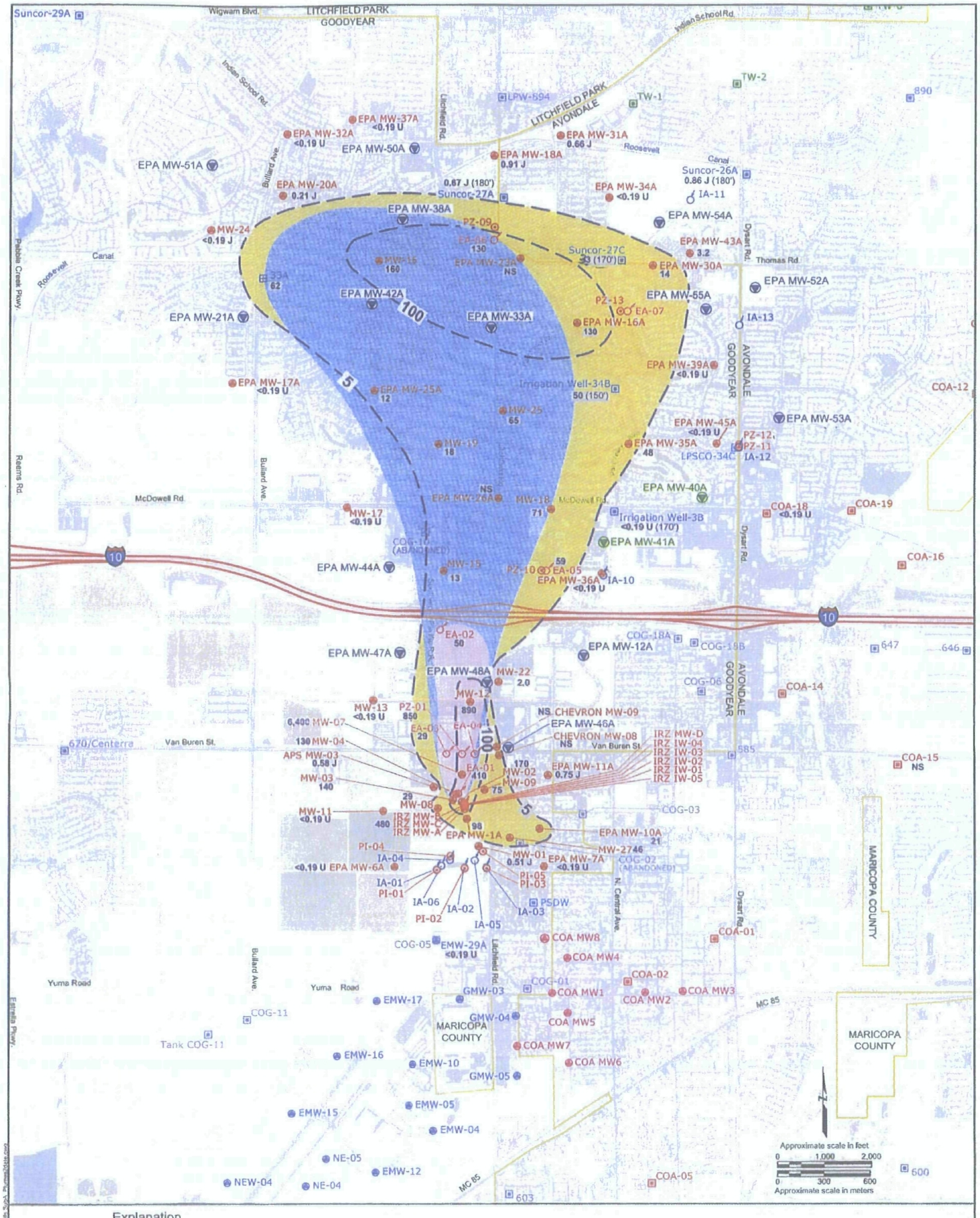
SUBUNIT A
TCE CONCENTRATION
SECOND QUARTER 2010

DRAWN BY:	DESIGNED BY:	APPROVED BY:	PROJECT NUMBER:
SH	JM	MH	10-100E-01
DATE: 07-09-2010	DATE: 07-09-2010	DATE: 07-09-2010	SCALE: 1"=2500'

FIGURE NUMBER: 5

Attachment II



Explanation

EPA MW-41A	Remaining Proposed Year 3 Subunit A monitor well
EPA MW-55A	Proposed remaining Subunit A monitor well
EPA MW-45A	Subunit A monitor well
EA-07	Subunit A extraction well
EMW-29A	Subunit A monitor well - PGA South site
COA MW1	Subunit A monitor well Western Ave. Plume site
PZ-13	Piezometer
IA-13	Injection well (treated water)
IRZ IW-01	Injection well (IRZ)
COA-18	City of Avondale supply well
COG-18A	City of Goodyear well
LPSCO-34C	Litchfield Park Services Co. production well
33A	SunCor / UPI treatment system well
Suncor-27A	Palm Valley / SunCor irrigation well
6,400	Trichloroethene (TCE) concentration in micrograms per liter (µg/L) (Feb 2010)
(180')	Depth of discrete analytical result in feet below ground surface
U	The analyte was analyzed for, but was not detected above the reported sample quantitative limit
J	The anaylte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
NS	Not sampled
— —100—	Isocontour showing TCE concentration in µg/L (Feb 2010)
	Plume as of February 2010
	Plume as of approximately 2005
	Plume as of approximately 1995

PROPOSED REMAINING MONITOR WELLS FOR GROUNDWATER INVESTIGATION SUBUNIT A

Phoenix Goodyear Airport North Superfund Site
Goodyear, Arizona

By: jrw	Date: 6/3/10	Project No. 0146821050
AMEC Geomatrix		Figure 1

Attachment III

INITIAL BOREHOLE AND MONITOR WELL INSTALLATION CHART

ATTACHMENT C-1

Table No.	Priority/ Schedule	Well Location and Designation	Purpose for Well Installation	Drilling and Well Construction Details^	Priority 3 Contingent Well and Criteria for Installation
PRIORITY ONE WELLS AND CONTINGENT THREE WELLS					
1	Priority 1/ Year 1	**MAU On UPI Property** **28M, 1M***	Investigate potential impact in MAU, and if contamination present, evaluate the vertical extent of impact. Provide groundwater elevation data point for groundwater flow model.	**28M**: Use SimulProbe into MAU to vertical extent of impact, or at least 50 feet if no exceedences of Site-specific cleanup levels or performance standards are found in MAU. Install well in clean MAU zone. **1M**: Use Simulprobe to at least former completion depth (514 feet) of COG-04 to evaluate vertical impact and install well in clean zone.	**1) 2M** - Install if either 28M or 1M location indicates exceedances of Site-specific cleanup levels or performance standards for Site-related contamination for two consecutive quarterly[a] sampling events. **2) 1C** - Install if results from 1M boring Simulprobe exceed 5x Site-specific cleanup levels or performance standards in any sample interval in Subunit C.
2	Priority 1/ Year 1	**Eastern Site Boundary** **9C**	Delineate groundwater flow direction and lateral extent of contamination in Subunit C. Characterize pathways into COG-02. Sentinel well for COG-03. Pair with MW-27 for vertical hydraulic head evaluation.	If results from 28M or 1M show any exceedences of Site-specific cleanup levels or performance standards in the MAU, or if Simulprobe results at base of Subunit C in this location exceed Site-specific cleanup levels or performance standards, use SimulProbe at least 50 feet (if no impact) or to vertical extent of impact. Install Subunit C well in most impacted zone.	**1) 10C** - Install in the event well at 9C location indicates exceedances of Site-specific cleanup levels or performance standards for Site-related contamination for two consecutive quarterly[a] sampling events **2) 8C** - Install a) if water quality data from wells at 9C or 10C (if installed) indicate exceedances of Site-specific cleanup levels or performance standards for Site-related contamination for two consecutive quarterly[a] sampling events, or b) as a sentinel well for City of Avondale wellfield if there is a component of Subunit A or C groundwater flow to the southeast of UPI toward the City of Avondale production wells.
3	Priority 1/ Year 1	**Southwestern Site Boundary** **6C**	Delineate groundwater flow direction and lateral extent of contamination in Subunit C. Sentinel well for COG-11.	If results from 28M or 1M show any exceedences of Site-specific cleanup levels or performance standards in the MAU, or if Simulprobe results at base of Subunit C in this location exceed Site-specific cleanup levels or performance standards, use SimulProbe at least 50 feet (if no impact) or to vertical extent of impact. Install Subunit C well in most impacted zone.	

INITIAL BOREHOLE AND MONITOR WELL INSTALLATION CHART

ATTACHMENT C-1

Table No.	Priority/ Schedule	Well Location and Designation	Purpose for Well Installation	Drilling and Well Construction Details^	Priority 3 Contingent Well and Criteria for Installation
4	Priority 1/ Year 1	**Northeast Distal End of Plume** **16A, 18A, 20A**	Delineate groundwater flow direction and lateral extent of contamination in Subunit A. Evaluate capture from extraction well 33A. Possible future conversion of 16A or 18A to extraction function as necessary for plume capture.	Use Simulprobe to sample groundwater to base of Subunit A at each of these three locations. Install 2-3 wells at locations where results are below Site-specific cleanup levels or performance standards for Site-related contamination to delineate the NE plume boundaries.	
5	Priority 1/ Year 1	**Northern UPI Boundary** **Subunit C Extraction Well - Return MW-20 to Monitor Well Status**	Enhance Subunit C hydraulic capture. Allow MW-20 to return to functioning as a monitor well to evaluate capture from new extraction well.	Install extraction well to provide increased extraction rates. Return MW-20 to monitor well status.	**4C** - Install if there is inconclusive (i.e. if there is little or no draw-down) data from MW-20 such that a capture zone delineation cannot be completed.
6	Priority 1/ Year 1	**Northwestern Site Boundary** **4A**	Monitor remedial system effectiveness from extraction well EA-03.	Following EPA review and approval of well construction and current conditions, add Arizona Public Service (APS) well MW-3 to monitoring program. If APS well not adequate for task, install Subunit-A well at this location.	**4C** - Install if 4A results indicate exceedances of Site-specific cleanup levels or performance standards for Site-related contamination for two consecutive quarterly[a] sampling events.
7	Priority 1/ Year 1	**On UPI Property** **27A**	Evaluate groundwater quality near former drywell source area. Possibly future conversion to in-situ treatment or extraction well.	Install well in accordance with the Source Areas Investigation Workplan, upon approval by EPA. Construct minimum 4-inch diameter well that spans water table.	
8	Priority 1/ Year 1	**NW Plume Area** **Sampling of Suncor 27A**	Sample existing Suncor well to assess nature and extent of impact from Site-related contamination in northwest plume area.	Collect depth-specific samples using discrete-interval sampler as one-time sampling event, and submit for laboratory analysis of Site-related contamination.	Should intervals exceed Site-specific cleanup levels or performance standards for Site-related contamination, monitor well installation may be required.

INITIAL BOREHOLE AND MONITOR WELL INSTALLATION CHART

ATTACHMENT C-1

Table No.	Priority/ Schedule	Well Location and Designation	Purpose for Well Installation	Drilling and Well Construction Details^	Priority 3 Contingent Well and Criteria for Installation
9	Priority 1/ Year 1	**Northern Plume Area** **25A**	Monitor groundwater concentrations near the center of the plume at the distal end. Pair with Subunit C well MW-26 to measure groundwater head differentials between Subunits A and C. Characterize potential threat to Subunit C.	Use Simulprobe to sample groundwater to base of Subunit A, and install well in most impacted zone or at base of Subunit A if results are non-detect (ND).	
10	Priority 1/ Year 1	**Northern Plume Area** **17A**	Delineate groundwater flow direction and lateral extent of contamination in Subunit A. Evaluate capture from extraction well 33A.	Use Simulprobe to sample groundwater to base of Subunit A, and install well where results are below the MCL, to delineate the plume boundary.	
11	Priority 1/ Year 1	**Northern Plume Area** **24C***	Evaluate vertical extent of impact at distal end of plume. Evaluate if Subunit C is impacted from conduit wells and/or vertical migration from Subunit A. Sentinel well for Algonquin well 55-611717 (Section 20), with flow rate of 1500-1600 gpm.	If Site-related contaminants are present above Site-specific cleanup levels or performance standards at the base of Subunit C, use Simulprobe at least 50 feet into MAU to evaluate vertical extent of impact, and install well at selected depth within Subunit C.	1) **21C** - Install if completed well at 24C indicates exceedances of Site-specific cleanup levels or performance standards for Site-related contamination for two consecutive quarterly[a] sampling events. 2) **22C** - Install if completed well at 21C indicates exceedances of Site-specific cleanup levels or performance standards for Site-related contamination for two consecutive quarterly[a] sampling events.
PRIORITY TWO WELLS AND CONTINGENT PRIORITY THREE WELLS					
12	Priority 2/ Year 2	**West of UPI** 5C	Evaluate western extent of Subunit C plume. Pair with MW-11 for vertical hydraulic head evaluation. Sentinel well for City of Goodyear Centerra well on Van Buren Road.	If results from 28M or 1M show any exceedences of Site-specific cleanup levels or performance standards in the MAU, or if Simulprobe results at base of Subunit C in this location exceed Site-specific cleanup levels or performance standards, use SimulProbe at least 50 feet (if no impact) or to vertical extent of impact. Install Subunit C well in most impacted zone.	

INITIAL BOREHOLE AND MONITOR WELL INSTALLATION CHART

ATTACHMENT C-1

Table No.	Priority/ Schedule	Well Location and Designation	Purpose for Well Installation	Drilling and Well Construction Details^	Priority 3 Contingent Well and Criteria for Installation
13	Priority 2/ Year 2	**Eastern Site Boundary** **10A and 11A**	Characterize eastern extent of Subunit A plume.	Use Simulprobe to sample groundwater to base of Subunit A, and install well where results are below the Site-specific cleanup levels or performance standards for Site-related contamination (delineating plume boundary).	
14	Priority 2/ Year 2	**Southern Site Boundary** **6A and 7A**	Characterize southern extent of Subunit A plume. Evaluate potential for groundwater divide at Yuma Road.	Use Simulprobe to sample groundwater to base of Subunit A, and install well where results are below the Site-specific cleanup levels or performance standards for Site-related contamination (delineating plume boundary).	
15	Priority 2/ Year 2	**NE Site Boundary** **12A**	Characterize northeastern extent of Subunit A plume.	Use Simulprobe to sample groundwater to base of Subunit A, and install well where results are below the Site-specific cleanup levels or performance standards for Site-related contamination (delineating plume boundary).	
16	Priority 2/ Year 2	**NW Plume Area** **19A**	Delineate groundwater flow direction and lateral extent of contamination in Subunit A. Evaluate capture from extraction well 33A. Replacement for lost monitoring well in this area (Globe Wells).	Use Simulprobe to sample groundwater to base of Subunit A, and install well where results are below the MCL (delineating plume boundary). Following EPA review and approval of well construction and current conditions, Globe-04 may be considered for use as 19A.	**21A** - Install if data from wells 19A, 20A or MW-24 indicate exceedances of Site-specific cleanup levels or performance standards for Site-related contamination for two consecutive quarterly[a] sampling events.
17	Priority 2/ Year 2	**Central Plume Area** **3C***	Evaluate remedial system effectiveness from Subunit C well MW-20. Pair with MW-07 for vertical hydraulic head evaluation for flow model.	Use Simulprobe to base of Subunit C, and install well within Subunit C at same screened interval as MW-20.	

INITIAL BOREHOLE AND MONITOR WELL INSTALLATION CHART

ATTACHMENT C-1

Table No.	Priority/ Schedule	Well Location and Designation	Purpose for Well Installation	Drilling and Well Construction Details^	Priority 3 Contingent Well and Criteria for Installation
18	Priority 2/ Year 2	**Central Plume Area** **1A***	Evaluate groundwater quality and flow direction near COG-04. Evaluate groundwater reinjection impacts from formerly operated wells IA-01 through IA-05.	Install well based on Simulprobe results. Pair with 1C and 1M for vertical hydraulic head evaluation near COG-04, for flow model.	
ADDITIONAL PRIORITY THREE WELLS					
19	Priority 3/ Year 3	**NE Plume Area** **13C**	Delineate groundwater flow direction and lateral extent of contamination in Subunit C. Sentinel well for COG-18A and 18B.	If results from 28M or 1M show any contamination in the MAU, or if Simulprobe results at base of Subunit C in this location exceed Site-specific cleanup levels, use SimulProbe at least 50 feet (if no impact) or to vertical extent of impact. Install Subunit C well in most impacted zone.	**13C** - Install if MW-28 indicates exceedances of Site-specific cleanup levels or performance standards for Site-related contamination for two consecutive quarterly[a] sampling events, and if well is within 5-year time of travel for COG wells, as predicted using EPA WHPA or site-specific model.
20	**Priority 3/ Year 3**	**East and West Central Plume Areas** **14A and 15A**	Monitor remedial system effectiveness and capture zone at EA-02.	Install well in Subunit A at same screened interval as EA-02.	**14A and 15A** - Install both wells if EA-02 capture zone analysis does not confirm predicted capture zone, or if inadequate data from other monitor wells to confirm modeled capture zone.
WELLS CURRENTLY DEFERRED#					
21		**Central/SW Plume Area** **2C**	Evaluate SW extent of Subunit C plume. Pair with MW-08 for vertical hydraulic head evaluation for flow model.	Use Simulprobe and install well at most impacted interval within Subunit C.	
22		**North Plume Area** **23A, 24A & 26A**	Monitor concentrations within center of plume at distal end for fate transport modeling.	Install well at most impacted interval within Subunit A.	

__Table Notes:__

^ During Simulprobe work, if the overlying water bearing zone shows Site-related contaminants present above the Site-specific cleanup levels or performance standards, isolation casing must be installed through the overlying zone. If the overlying water bearing zone does not show Ssite-related contaminants present above the Ssite-specific cleanup levels or performance standards, isolation casing may not be needed. However these procedures must be approved in a work plan for installation of these monitor wells.

[a] The quarterly sampling events will consist of the 1[st] sampling event conducted as soon as practicable after well installation, and the 2[nd] sampling event conducted during the next regularly scheduled sample event. Therefore, the time period between the two

events may be less than a quarter.

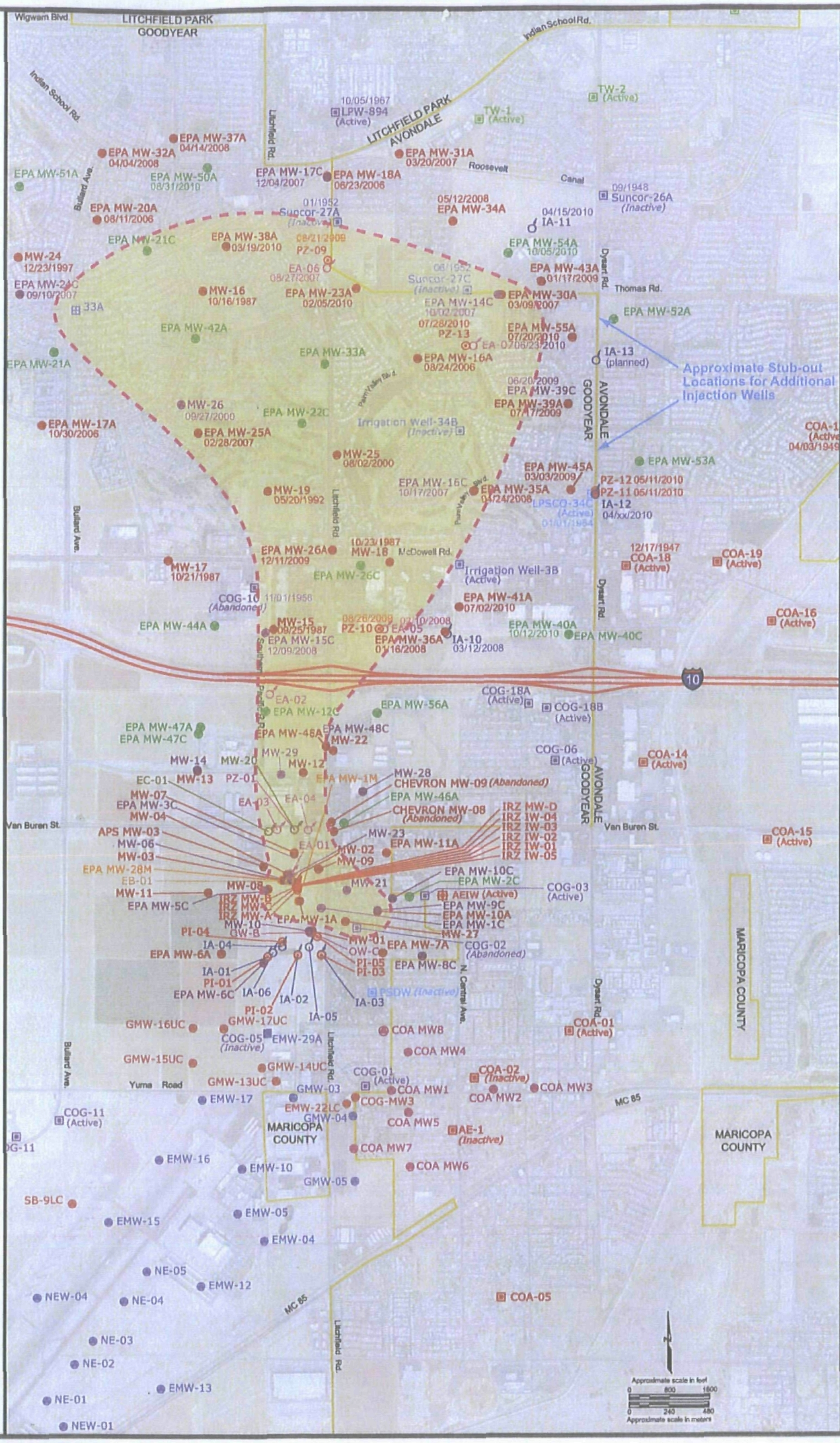
*** Well added to Priority 1, 2 or 3 list by EPA - July 27, 2004.**

 # Wells currently deferred but may be needed pending outcome of results from Priority 1, 2 and 3 wells.

Evaluating vertical extent of impact in the MAU requires that at least two consecutive Simulprobe intervals show concentrations below Site-specific cleanup standards.

Priority 3 wells: Install all contingency wells utilizing the same drilling and well construction details as indicated for the well on which its contingency is based.

Attachment IV



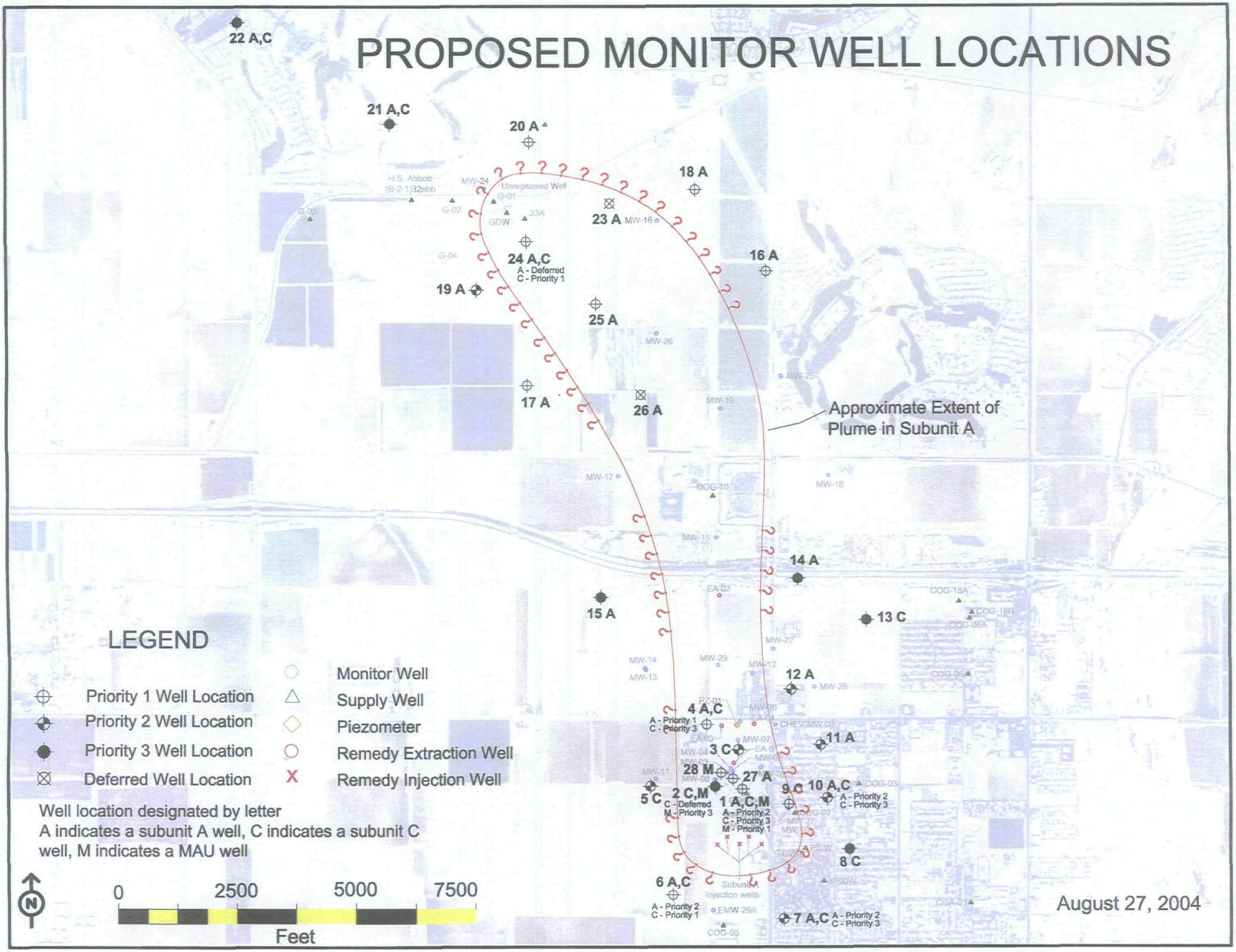
Explanation

EPA MW-53A	Proposed remaining Subunit A monitor well
EPA MW-55A	Subunit A monitor well
EA-07	Subunit A extraction well
EMW-29A	Subunit A monitor well - PGA South site
COA MW1	Subunit A monitor well Western Ave. Plume site
PZ-13	Piezometer
IA-13	Injection well (treated water)
IRZ IW-01	Injection well (IRZ)
33A	SunCor / UPI treatment system well
Suncor-27A	Palm Valley / SunCor irrigation well
LPSCO-34C	Litchfield Park Services Co. production well
	Approximate TCE Plume Distribution - May 2010 (Reported by Matrix New World Engineering, Inc. in G roundwater Monitoring Report - Second Quarter 2010 Groundwater Monitoring Report)
EPA MW-48C	Proposed remaining Subunit C monitor well
EPA MW-48C	Subunit C monitor well
EPA MW-28M	MAU monitor well
EB-01	Subunit B extraction well
EC-01	Subunit C extraction well
OW-B	Observation well
COG-18A	City of Goodyear well
PSDW	Park Shadows production well
COG-MW3	Subunit C monitor well - PGA South site
COA-02	City of Avondale supply well
AEIW	Avondale Elementary irrigation well
TW-1	Algonquin water services well

All dates shown are well installation dates.

FIGURE 2
WELL LOCATIONS FOR GROUNDWATER INVESTIGATION AND REMEDIAL ACTIVITIES
Phoenix Goodyear Airport North Superfund Site
Goodyear, Arizona

CH2MHILL


PROPOSED MONITOR WELL LOCATIONS
22 A,C
21 A,C
20 A
18 A
23 A
24 A,C
A - Deferred
C - Priority 1
16 A
19 A
25 A
17 A
26 A
Approximate Extent of Plume in Subunit A
14 A
15 A
13 C
12 A
4 A,C
A - Priority 1
C - Priority 3
11 A
3 C
28 M
27 A
5 C
2 C,M
C - Deferred
M - Priority 3
1 A,C,M
A - Priority 2
C - Priority 3
M - Priority 1
9 C
10 A,C
A - Priority 2
C - Priority 3
8 C
6 A,C
A - Priority 2
C - Priority 1
7 A,C
A - Priority 2
C - Priority 3
Subunit A Injection wells
LEGEND
Priority 1 Well Location
Priority 2 Well Location
Priority 3 Well Location
Deferred Well Location
Monitor Well
Supply Well
Piezometer
Remedy Extraction Well
Remedy Injection Well
Well location designated by letter
A indicates a subunit A well, C indicates a subunit C well, M indicates a MAU well
0
2500
5000
7500
Feet
N
August 27, 2004

Attachment V

Innovative Technical Solutions, Inc.

Technical Memorandum

To:	Catherine Brown, RPM, EPA Region 9
From:	Ailiang Gu, PhD, RG, ITSI/Tempe Nancy Nesky, PE ITSI/Tempe
Date:	August 24, 2010
Subject:	Hydraulic Gradient/Flow Vector Evaluation and Hydraulic Mounding Analysis for Injection Wells (IA-11, IA-12, IA-13, IA-14, IA-15, and IA-10) at the Phoenix-Goodyear Airport North (PGAN) Superfund, Goodyear, Arizona

Contract /TO: EP-S9-08-03 / TO # 0006 **ITSI DCN:** 07163.0005.0074

Summary

Innovative Technical Solutions, Inc. (ITSI), on behalf of the U.S. Environmental Protection Agency (EPA), has prepared this technical memorandum to (1) evaluate the hydraulic gradients /flow vectors in the area north of I-10 at the PGAN Superfund Site, and (2) perform hydraulic mounding analyses and radius of influence calculations for the newly installed and proposed injection wells (IA-11, IA-12, IA-13, IA-14, IA-15 and IA-10). The mounding analysis was performed using a specific yield (S_y) of 0.1 and 0.2. The results are found in the table at the end of this document.

The hydraulic gradient/flow vector analyses and mounding analyses show that: (1) groundwater flow direction in NE area is still towards N/NE, which suggests establishing a effective hydraulic barrier is critical to contain the TCE plume in Subunit A in this area: (2) Subunit A groundwater flow direction changes in most plume area north of I-10 starting early this year is primarily controlled by three monitoring wells (EPA MW-35A, EPA MW-45A, and EPA MW-39A), which are ultimately caused by the decrease in groundwater pumping in the vicinity or in the region, and/or increased recharge from the flooding event in Agua Fria River in January 2010 (and Avondale Wetlands recharge site). The NW shift in groundwater flow is likely temporary, as evident by the continuous decrease of water levels at these monitoring wells; and (3) there are significant gaps between the areas of influence associated with three injection wells, and five injection wells will improve the plume containment, though will not completely eliminate the gaps. One big advantage for five injection wells is that the injection activities will be more effectively managed under various flow regimes.

1. Hydraulic Gradient/Flow Vector Evaluation and Analysis

Figures 1 to 5 present the hydraulic gradient /flow vector maps for 1st Quarter 2007, 1st Quarter 2008, 1st Quarter 2009, 1st Quarter 2010, and 2nd Quarter 2010, respectively. These maps show the historical changes in the groundwater gradients and flow directions in the area of north of Interstate (I-10) at the Site for the past four years. This timeframe includes the time periods of before and after installation of extraction wells EA-05 and EA-06 in the area north of I-10 at the Site.

As clearly shown in the maps, groundwater flow direction changes started in 1st Quarter of 2010 in some parts of the area, indicating NW shift of groundwater flow directions; however, the N/NE component of the groundwater flow still existed in the NE area during the 1st Quarter and 2nd Quarter of 2010(Figure 4 and 5), which are different with the analyses shown in respective figures in Crane Co's July 20th, 2010 response letter to EPA.

In Crane Co.'s Figure 3 (4th Quarter Of 2009) hydraulic gradient/flow vector analysis, one critical well, EPA MW-43A, was excluded from the analysis. In Crane Co.'s Figure 4 (2nd Quarter of 2010) hydraulic gradient/flow vector analysis, two critical wells, EPA MW-30A and EPA MW-43A, were excluded from the analysis. These omissions produced a flawed hydraulic gradient /flow vector analysis in the NE area. **Had Crane Co. considered the water level data from these two monitoring wells, they would clearly see that groundwater in northeast portion of the Site continues flowing towards to the north/northeast, away from extraction well EA-06.**

Water quality data at monitoring well EPA MW-30A also strongly supports the continuously present N/NE groundwater flow direction in NE portion of plume. TCE concentration in well EPA MW-30A has increased from February 2010 (see the followings) to July 2010. The TCE concentration increase cannot be explained by the NW groundwater flow directions in this area.

Time	Concentration (µg/L)
2/2010	14
3/2010	16
4/2010	23
5/2010	30
6/2010	30
7/2010	29

The NW shift in groundwater flow directions in Subunit A north I-10 starting in 1st Quarter 2010 is primarily driven by the higher water levels at three monitoring wells, namely EPA MW-39A, EPA MW-35A, and EPA MW-45A (Figure 6). In addition to these wells, Figure 6 also shows that groundwater levels at many other Subunit A monitoring wells have also increased since the beginning of this year. The high groundwater levels at wells EPA MW-39A, EPA MW-35A and EPA MW-45A is likely caused by less groundwater pumping at the regional water supply (and irrigation) wells and/or recharge from the big floods at the Agua Fria River in January 2010 (Please see CH2M Hill's Technical Memo for additional information).

COA-18 and COA-19 had problems in SCADA systems earlier this year, and had minimum pumping from January to May 2010. The recharge at the Avondale Wetlands likely impacts the groundwater level at the monitoring wells such as EPA MW-45A, EPA MW-35A and EPA MW-39A, because the recharge is not captured by these two high-capacity water supply wells.

However, the groundwater levels at these three monitoring wells have declined since May or June 2010 due to the increased groundwater pumping in the vicinity (such as City of Avondale wells COA-18 and COA-19) or in the region (such as Liberty Water well TW-01 and many other wells). As we can see from the July 2010 hydrograph from the transducer data, the groundwater levels at well EPA MW-45A has further decreased since the beginning of July 2010 (Figure 7).

With regard to the impact of groundwater pumping to the groundwater levels in the area north of I-10, the effect is also shown in some of the Subunit C monitoring wells. Similar to Subunit A wells, groundwater levels at Subunit C wells EPA MW-16C, EPA MW-39C, and EPA MW-14C have also increased since the beginning of this year (Figure 8). Especially at well EPA MW-39C, groundwater level has increased 7.8 ft since December 2009. However, water level at this well peaked in May 2010, and has decreased 1.47 ft since early May.

The unusual high water levels in Subunit A wells and Subunit C wells in 1st Quarter and 2nd Quarter 2010 are likely in part due to the fact that 2009 winter is the wettest winter in Arizona history. Due to the excess surface water available at the reservoirs, SRP used much more surface water, and less groundwater for their water supply in this year, thus groundwater levels in the pumping centers (such as Township 2N Range 2E, where many of SRP's high capacity wells are located) increased. Similar effects could also likely be seen in big irrigation district such as Roosevelt Irrigation District (RID). This may explain in part the high water levels in the area north of I-10.

With further declining of water levels in the east plume area north of I-10, we will likely see most of the plume area will have groundwater flow directions returning to north/northeast. Therefore, a sufficient network of injection wells, combined with extraction wells, is critical to prevent further migration of TCE plume to the N/NE direction.

2. Hydraulic Mounding Analysis of Injection Wells

In order to evaluate the potential hydraulic mounding related to the existing and proposed injection wells, mounding analyses were conducted to injection wells IA-11, IA-12, IA-13, IA-14, and IA-15 under different injection rate, as well as IA-10 at 500 gpm. The mounding analyses of the injection wells are performed using Theis equation. The followings are the methodology and general assumptions:

Theis equation:

$$u = \frac{r^2 S}{4Tt}$$

$$s\,(r, t) = \frac{QW(u)}{4\pi T}$$

where:

r is the radius of the injection well (r = 0.5 ft)

S is storage coefficient; Subunit A is an unconfined aquifer, therefore, Storage coefficient is the same as specific yield, which is assumed to be 0.1 in this area.

T is transmissivity (ft^2/day), T= K× b where K is hydraulic conductivity (ft/day) and b is saturated aquifer thickness (saturated aquifer thickness is approximately 60 ft in the NE area, and it is approximately 80 ft in the vicinity of EA-05 and IA-10)

t is pumping time (in this case it is an injection time). It is assumed after 3 months of continuous injection, the mounding at the well is generally stabilized, or the associated extraction well will have a filter change which will disrupt the injection activities.

s(r, t) is drawdown (in ft)

u is a dimensionless constant

W(u) is a well function

2.1 IA-11

(a) Injection rate of 333 gallons per minute (gpm)

In the area of IA-11, aquifer test results are available from three Subunit A monitoring wells: EPA MW-34A (292 ft/day), EPA MW-30A (116 to 151 ft/day, average 133 ft/day), and EPA MW-43A (136 to 244 ft, average 190 ft/day). The geometric mean of the hydraulic conductivity of these three wells is 195 ft/day, which is used in the mounding calculation for injection well IA-11.

$u = \frac{r^2 S}{4Tt} = (0.5\ ft)^2 \times 0.1/(4 \times 195\ ft/day \times 60\ ft \times 90\ days) = 5.94 \times 10^{-9}$

from the well function table, we can find that W(u) = 18.35

$s\ (r, t) = \frac{QW(u)}{4\pi T} = [(333\ gpm \times 60\ minutes/hour \times 24\ hour/day)/7.48\ gal/ft^3] \times 18.35\ /(4 \times 3.14 \times 195\ ft/day \times 60\ ft)$

s (r, t) = 8.0 ft of drawdown

(b) Injection rate of 200 gpm

W(u) is the same as 333 gpm of injection rate.

s (r, t) = 4.8 ft of drawdown

2.2 IA-12

(a) Injection rate of 333 gpm

In the area of IA-12, aquifer test results are available from two Subunit A monitoring wells: EPA MW-45A (21 ft/day) and EPA MW-35A (8 to 31ft/day, average 19.5 ft/day). The arithmetic mean of the hydraulic conductivity of these two wells is 20 ft/day, which is used in mounding calculations at injection well IA-12.

$u = \frac{r^2S}{4Tt} =$ (0.5 ft)^2×0.1/(4 × 20 ft/day × 60 ft × 90 days) = 5.79 ×10^{-8}

from the well function table, we can find that W(u) = 16.05

$s\ (r, t) = \frac{QW(u)}{4\pi T} =$ [(333 gpm × 60 minutes/hour × 24 hour/day)/7.48 gal/ft^3] × 16.05 / (4×3.14 × 20 ft/day × 60 ft)

s (r, t) = 68.3 ft of drawdown

(b) Injection rate of 200 gpm

W(u) is the same as injection rate of 333 gpm.

s (r, t) = 41.0 ft of drawdown

2.3 IA-13

In the area of IA-13, aquifer test results are available from one Subunit A monitoring well: EPA MW-39A (3 to 9 ft/day, average 6 ft/day). In addition, from the well development information for extraction well EA-07, the estimated hydraulic conductivity is approximately 20 ft/day. The arithmetic mean of the hydraulic conductivity of these two wells is 14 ft/day, which is used in mounding calculations for injection well IA-13.

$u = \frac{r^2S}{4Tt} =$ (0.5 ft)^2 × 0.1/(4 × 14 ft/day × 60 ft × 90 days)=8.26 ×10^{-8}

from the well function table, we can find that W(u) = 15.76

$s\ (r, t) = \frac{QW(u)}{4\pi T} =$ [(333 gpm × 60 minutes/hour × 24 hour/day)/7.48 gal/ft^3] × 15.76 /(4 × 3.14 × 14 ft/day × 60 ft)

s (r, t) = 95.8 ft of drawdown

(c) Injection rate is 200 gpm

W(u) is the same as 333 gpm of injection rate.

s (r, t) = 57.5 ft of drawdown

2.4 IA-14

In the area of proposed injection well IA-14, pumping test results are available from two Subunit A monitoring wells: EPA MW-30A (116 to 151 ft/day, average 133 ft/day) and EPA MW-43A (136 to 244 ft/day, average 190 ft/day). The arithmetic mean of the hydraulic conductivity of these two wells is 160 ft/day, which is used in mounding calculations in injection well IA-14.

Injection rate = 200 gpm.

$u = \frac{r^2S}{4Tt} = (0.5\text{ ft})^2 \times 0.1/(4 \times 160\text{ ft/day} \times 60\text{ ft} \times 90\text{ days}) = 7.2 \times 10^{-9}$

from the well function table, we can find that W(u) = 18.20

$s(r, t) = \frac{QW(u)}{4\pi T} = [(200\text{ gpm} \times 60\text{ minutes/hour} \times 24\text{ hour/day})/7.48\text{ gal/ft}^3] \times 18.20 /(4 \times 3.14 \times 160\text{ft/day} \times 60\text{ ft})$

s (r, t) = 5.8 ft of drawdown

2.5 IA-15

In the area of proposed injection well IA-14, pumping test results are available from two Subunit A monitoring wells: EPA MW-35A (8 to 31 ft/day, average 19.5 ft/day) and EPA MW-45A (21 ft/day). The arithmetic mean of the hydraulic conductivity of these two wells is 20 ft/day, which is used in mounding calculation in injection well IA-15.

Injection rate = 200 gpm.

$u = \frac{r^2S}{4Tt} = (0.5\text{ ft})^2 \times 0.1/(4 \times 20\text{ ft/day} \times 60\text{ ft} \times 90\text{ days}) = 5.79 \times 10^{-8}$

from the well function table, we can find W(u) = 16.05

$s(r, t) = \frac{QW(u)}{4\pi T} = [(200\text{ gpm} \times 60\text{ minutes/hour} \times 24\text{ hour/day})/7.48\text{ gal/ft}^3] \times 16.05 /(4 \times 3.14 \times 20\text{ft/day} \times 60\text{ ft})$

s (r, t) = 41 ft of drawdown

2.6 IA-10

The same method is used to calculate the theoretical mounding of injection well IA-10, and the result is compared to actual groundwater mounding occurred at the well. The closest monitoring well EPA MW-36A has a hydraulic conductivity ranging from 63 to 89 ft/day with an average of 76 ft/day. This value is used in the mounding calculation. The saturated aquifer thickness in this area (obtained from well log information) is approximately 80 ft.

Injection rate is 500 gpm.

$u = \frac{r^2S}{4Tt} = (0.5\ \text{ft})^2 \times 0.1/(4 \times 76\ \text{ft/day} \times 80\ \text{ft} \times 90\ \text{days}) = 2.03 \times 10^{-8}$

from the well function table, we can find that W(u) = 17.15

$s(r, t) = \frac{QW(u)}{4\pi T} = [(500\ \text{gpm} \times 60\ \text{minutes/hour} \times 24\ \text{hour/day})/7.48\ \text{gal/ft}^3] \times 17.15/(4 \times 3.14 \times 76\ \text{ft/day} \times 80\ \text{ft})$

s (r, t) = 21.6 ft of drawdown

The actual mounding at well IA-10 after three months of injection is 57 ft (945 ft minus 888 ft). This likely suggests that the well efficiency of IA-10 is approximately 40%.

Groundwater mounding at monitoring EPA MW-36A due to the injection activities at well IA-10 can also be estimated. The distance between IA-10 and EPA MW-36A is approximately 20 ft, and the injection rate at IA-10 is 500 gpm.

$b_2^2 - b_1^2 = [Q/(\pi K)] \times \ln(r_2/r_1)$

$b_2^2 - (80-21.6)^2 = \{[500\ \text{gpm} \times 60\ \text{minutes/hour} \times 24\ \text{hour/day}/7.48\ \text{gallons/ft}^3]/(3.14 \times 76\ \text{ft/day})\} \times \ln(20/0.5)$

$b_2^2 = 58.4^2 + 1488 = 4899\ \text{ft}^2$, and

$b_2 = 70.0\ \text{ft}$

The calculated groundwater mounding at the monitoring well EPA MW-36A is then calculated as 80 ft -70.0 ft = 10.0 ft.

The actual groundwater mounding at well EPA MW-36A after three months of injection activities at IA-10 is approximately 3 ft, which is less than calculated value of 10 ft.

3. Radius of Influence Analyses of Injection Wells

The steady-state Thiem Equation for unconfined aquifer is used to estimate the radius of influence for the injection wells.

Thiem Equation:

$$b_2^2 - b_1^2 = [Q/(\pi K)] \times \ln(r_2/r_1)$$

then $\ln(r_2/r_1) = [(b_2^2 - b_1^2)\pi K]/Q$

where

Q is pumping rate (injection rate)

K is hydraulic conductivity

b_1 and b_2 are saturated thickness at the different location

r_1 and r_2 is the distance to the center of the pumping (injection) well

If we assume the area of one foot rise is important to build significant hydraulic barrier for an injection well, then we can use the theoretical mounding at the radius of the well to calculate the radius of influence (one foot rise) by using Thiem Equation. In this case, radius of the injection well $r_1 = 0.5$ ft.

IA-11 is used to estimate the maximum radius of influence of any existing or proposed injection wells at the PGAN site, since IA-11 likely has the highest hydraulic conductivity, and will likely have the largest radius of influence, if we assume storage coefficient (or specific yield in this case) is the same.

(a) Injection rate of 333 gpm

$\ln(r_2/0.5) = \{[(60\text{ft} - 1\text{ ft})^2 - (60\text{ft} - 8\text{ ft})^2] \times 3.14 \times 195\text{ ft/day}\}/[(333\text{ gpm} \times 60\text{ minutes/hour} \times 24\text{ hour/day})/7.48\text{ gallons/ft}^3] = 7.42$

then $2r_2 = e^{7.42} = 1670$ ft, and $r_2 = 850$ ft

So, the radius of influence is 850 ft.

(b) Injection rate of 200 gpm

Using the same method, the radius of influence at the IA-11 is calculated as 497 ft.

The radius of influence also could be calculated for injection IA-10:

$\ln(r_2/0.5) = \{[(80\text{ft} - 1\text{ ft})^2 - (80\text{ft} - 21.6\text{ ft})^2] \times 3.14 \times 76\text{ ft/day}\}/[(500\text{ gpm} \times 60\text{ minutes/hour} \times 24\text{ hour/day})/7.48\text{ gallons/ft}^3] = 7.0$

$2r_2 = e^{7.0} = 1100$ ft, and $r_2 = 550$ ft.

Therefore, the radius of influence for injection well IA-10 is estimated to be 550 ft.

This calculated value of radius of influence is generally consistent with the field observation data at IA-10.

4. Discussion

The following table summarizes the mounding analyses and radius of influence (one-foot water level rise) for the injection wells in two different injection scenarios (three injection wells vs. five injections wells) at the PGAN Site.

Table 1 Injection Well Mounding and Radius of Influence Analyses

Scenario 1: 3 injection wells (total injection rate of 1000 gpm, or 333 gpm per well)			
Wells	*Calculated Mounding (ft)*	*Actual Mounding (ft)*	*Radius of Influence (ft)*
	$S_y = 0.1$ ($S_y = 0.2$)		
IA-11	8.0 (7.7)	NA	850
IA-12	68.3 (65.7)	NA	
IA-13	95.8 (91.7)	NA	
Scenario 2: 5 Injection Wells (Total Injection Rate of 1000 gpm, or 200 gpm per well)			
IA-11	4.8 (4.6)	NA	497
IA-12	41.0 (39.4)	NA	
IA-13	57.5 (55.1)	NA	
IA-14	5.8 (5.6)	NA	
IA-15	41.0 (39.4)	NA	
IA-10 (500 gpm)	21.6 (20.7)	57	550

In three-injection well scenario, the estimated distance between IA-11 and proposed IA-13 is approximately 2, 900 ft; while it is approximately 2,600 ft between IA-13 and IA-12. The radius of influence analyses indicate that there are going be big gaps between the injection wells, and the TCE plume could not be fully contained. In addition, if the field hydraulic conductivity value turns out to be similar to the estimated value, then well IA-13 will have difficulty in handling an injection rate of 330 gpm.

In five-injection well scenario, the estimated distance between IA-11 and proposed injection well IA-14 is1,900 ft; and it is 1,100 ft between IA-14 and IA-13; 1,400 ft between IA-13 and IA-15; and 1,000 ft between IA-15 and IA-12. In this scenario, the gaps between the injection wells are narrower than in three injection well scenario, however, there will still be gaps between the injection wells, especially between IA-11 and IA-14.

Five-injection well scenario has much more advantage than the three-injection well scenario, and it has more freedom to change the injection arrangement to accommodate the changing groundwater, thus is more effective in containing the TCE plume in the NE area.

5. Method Limitations

There are numerous assumptions and limitations associated with Theis Equation and Thiem Equation. The applications of these two equations to calculate the groundwater mounding and radius of influence are limited by these assumptions. The results of the calculations should be evaluated carefully with these limitations in mind; nonetheless, they provide the estimated values and should provide preliminary guidance in planning and siting of future injection wells.

Please contact Ailiang Gu (480-706-6488 ext 3400, agu@itsi.com) or Nancy Nesky (ext 3390, nnesky@itsi.com) with any questions about this technical memorandum.

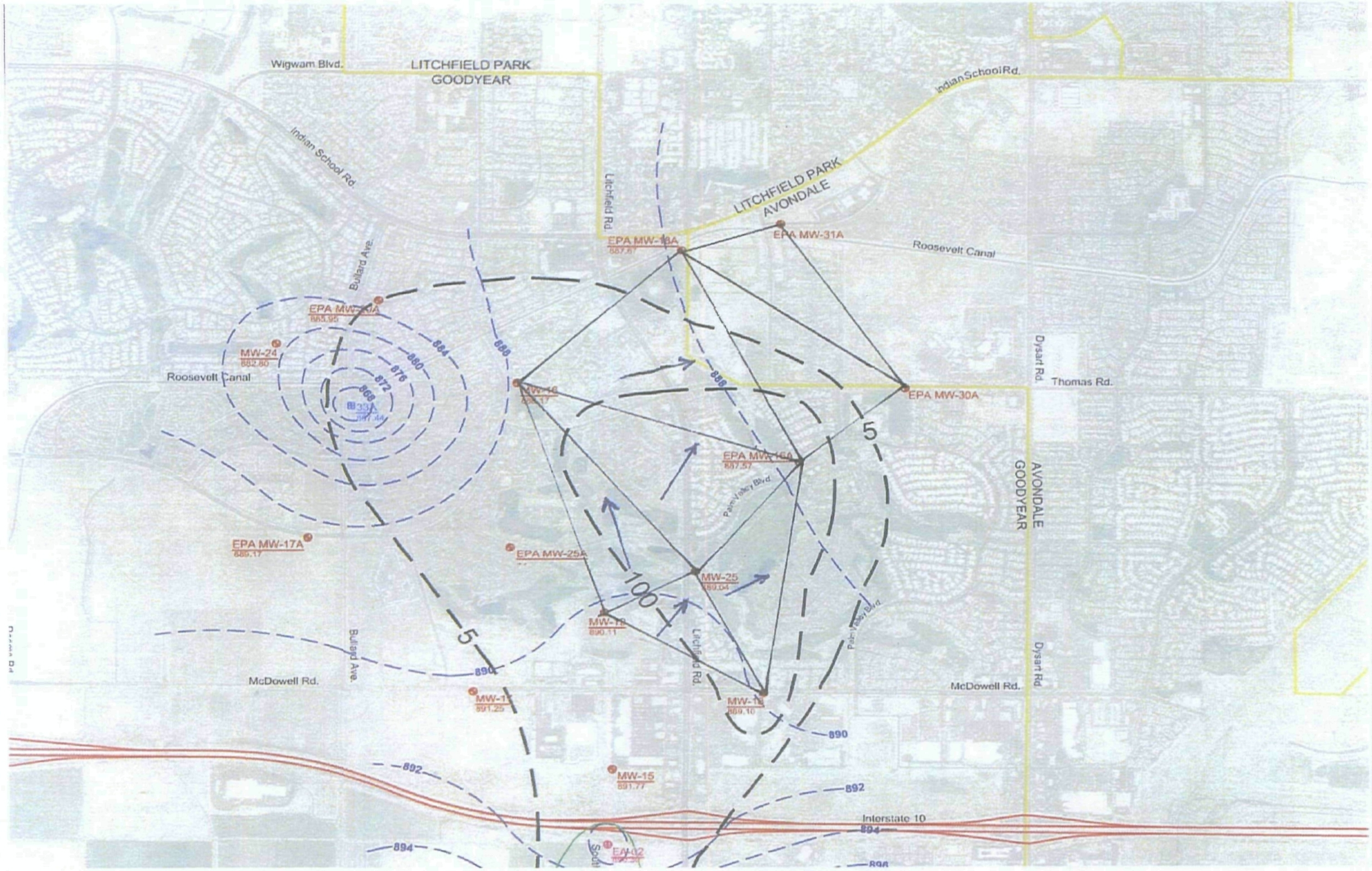


Figure 1 1st Quarter 2007 Hydraulic Gradient/Flow Vector Evaluation

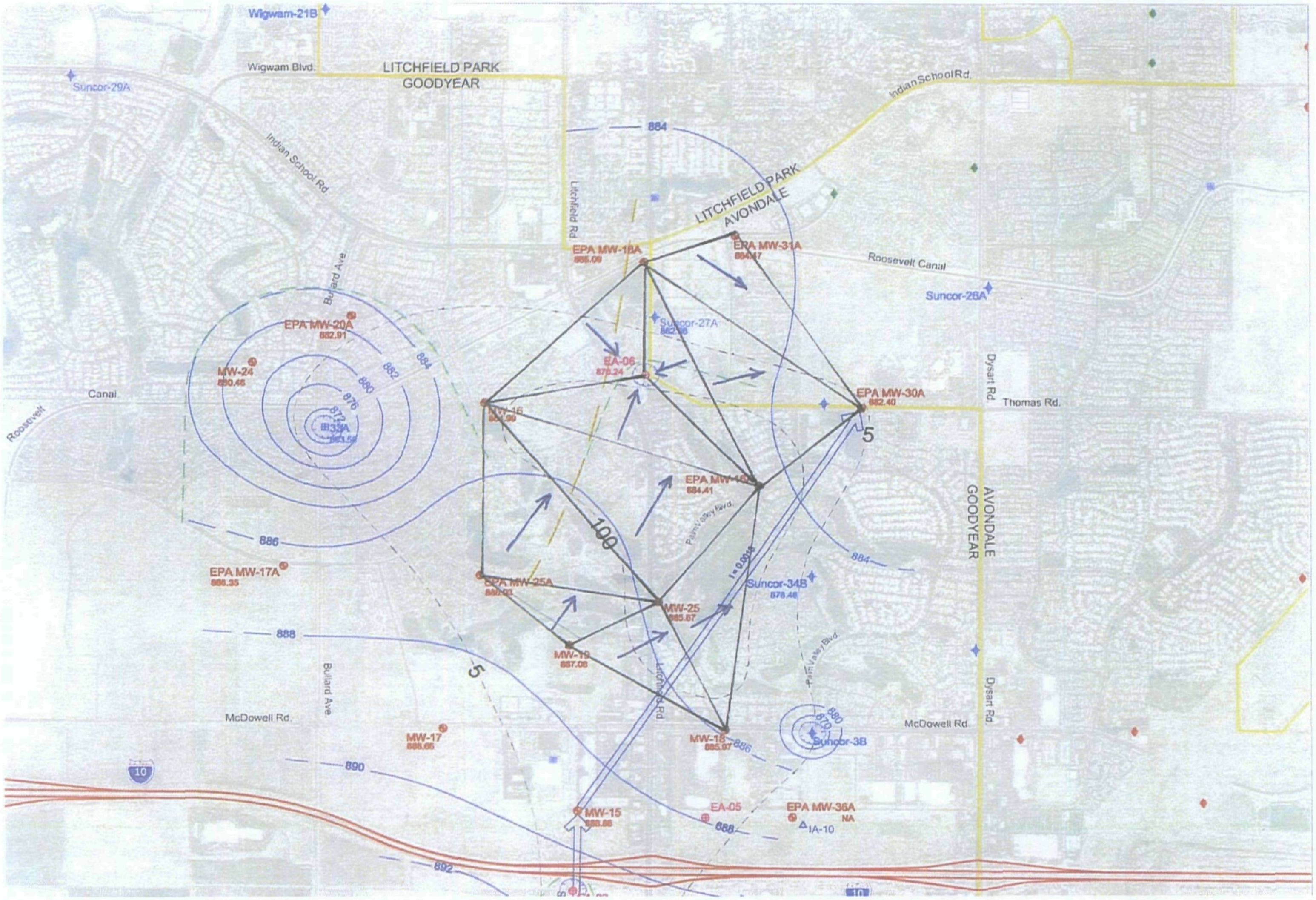


Figure 2 1[st] Quarter 2008 Hydraulic Gradient/Flow Vector Evaluation

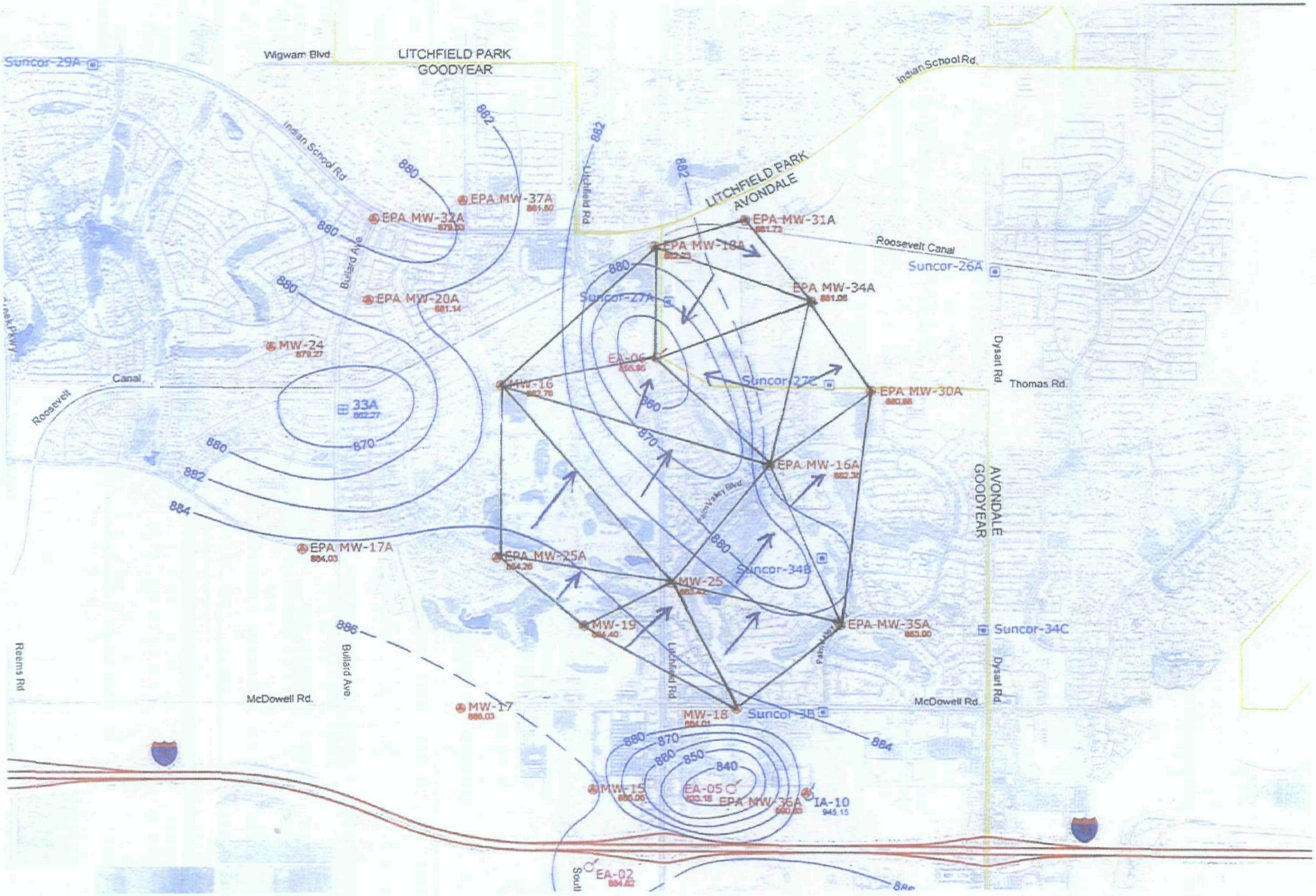


Figure 3 1st Quarter 2009 Hydraulic Gradient/Flow Vector Evaluation

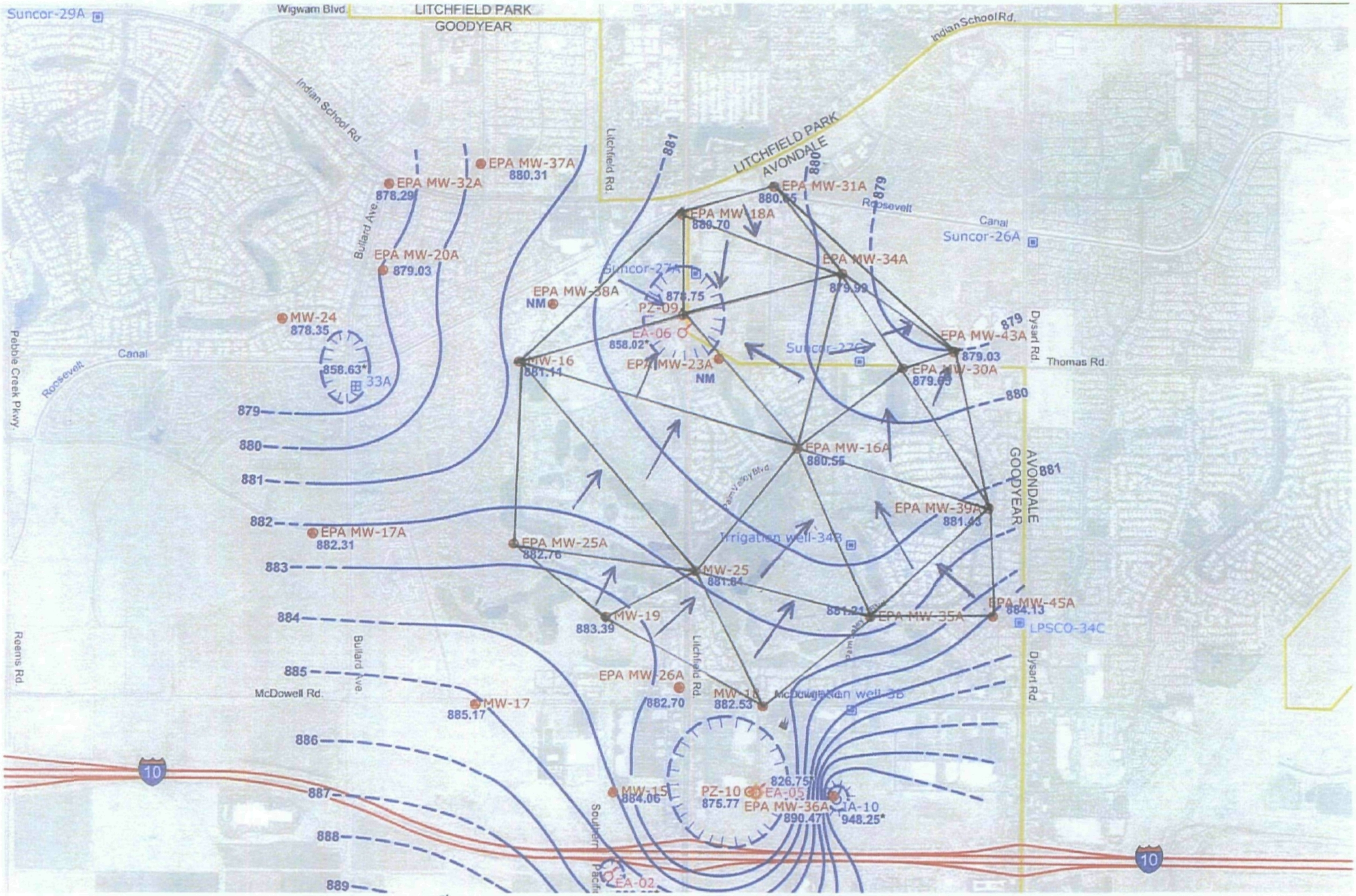


Figure 4 1st Quarter 2010 Hydraulic Gradient/Flow Vector Evaluation

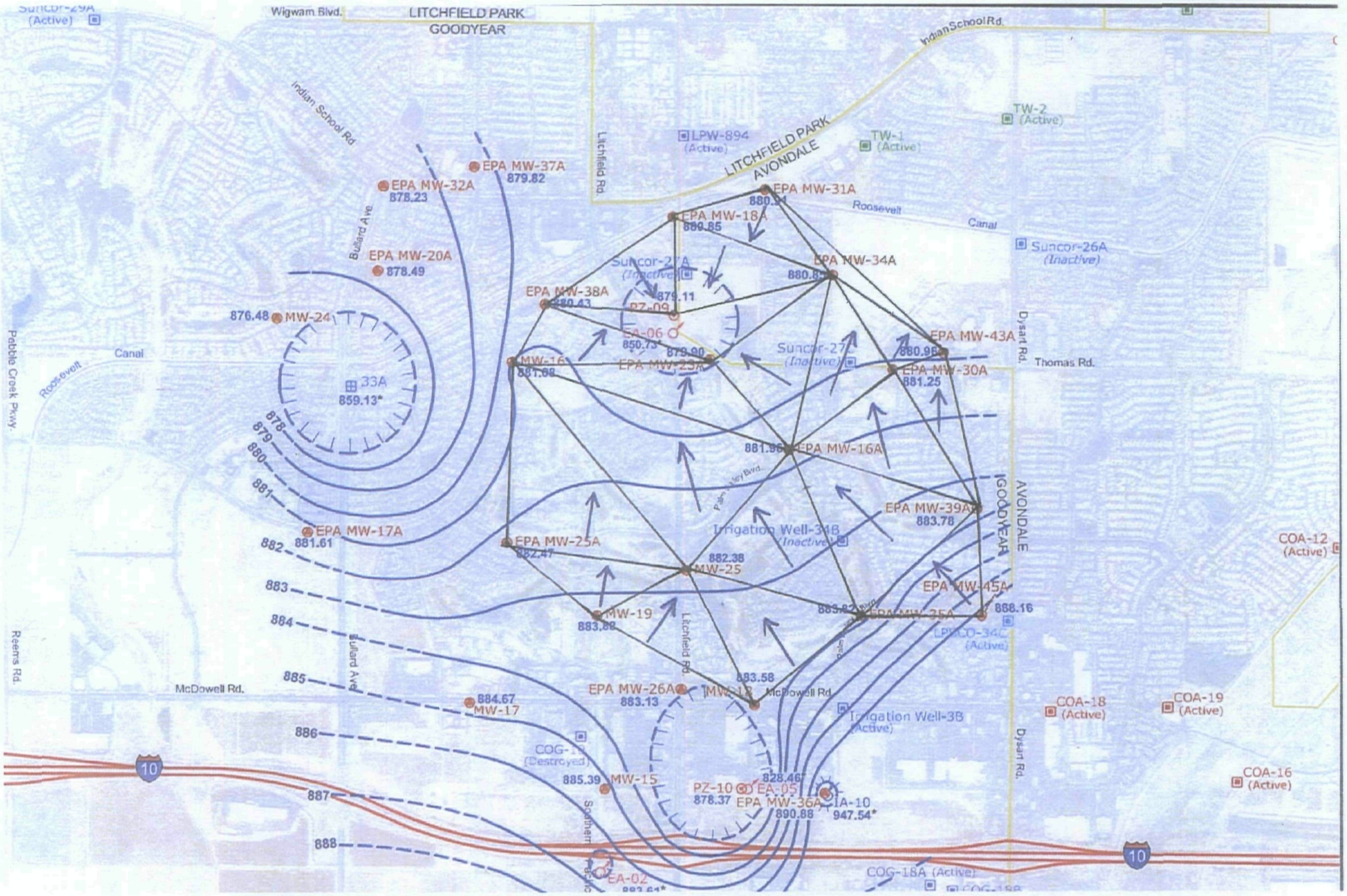


Figure 5 2nd Quarter 2010 Hydraulic Gradient/Flow Vector Evaluation

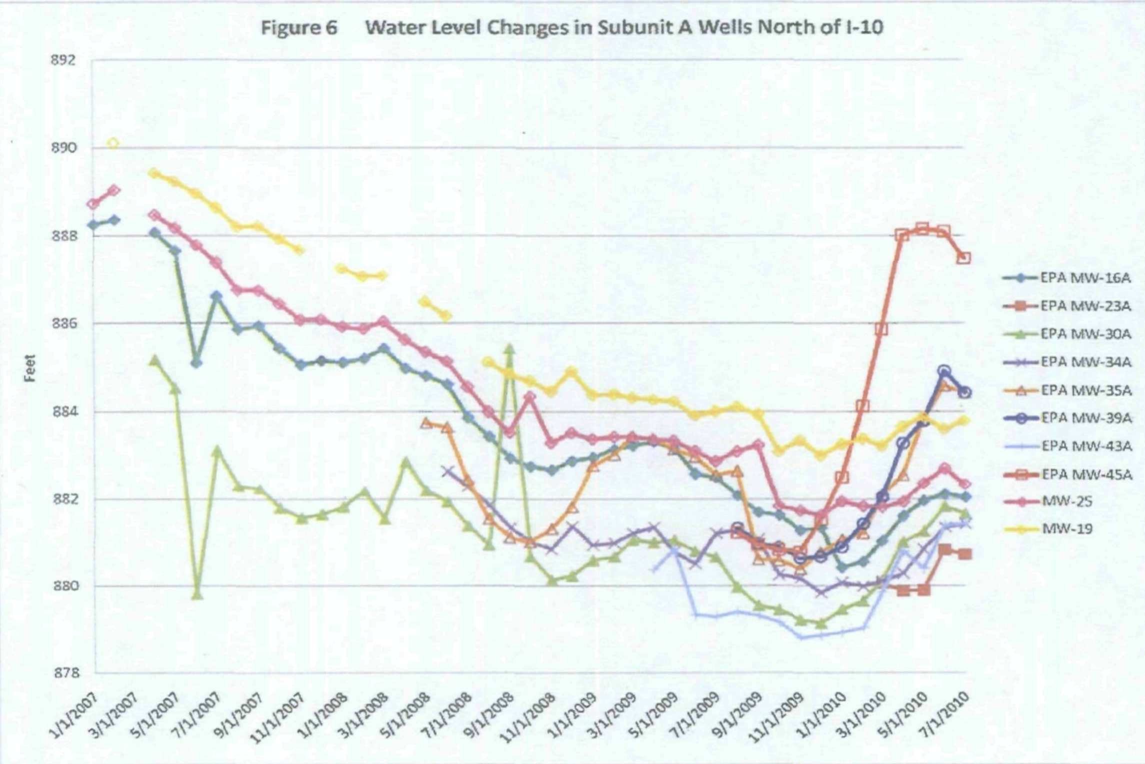


Figure 6 Groundwater Level Changes in Subunit A Monitoring Wells in North of I-10

Figure 7 Hydrograph for Monitoring Well EPA MW-45A (Data source: July 2010 PGAN Monthly Report)

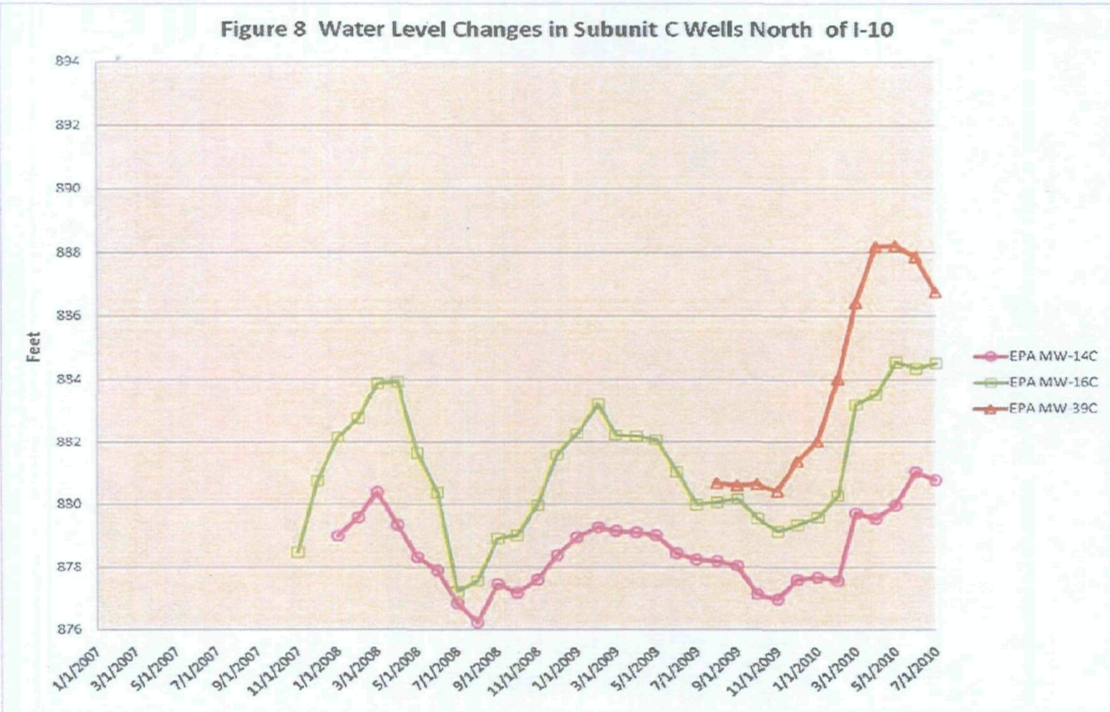


Figure 8 Groundwater Level Changes in Subunit C Monitoring Wels in North of I-10

Attachment VI

Innovative
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Technical Memorandum

To:	Catherine Brown, RPM, EPA Region 9
From:	Ailiang Gu, PhD, RG, ITSI/Tempe Nancy Nesky, PE ITSI/Tempe
Date:	August 30, 2010
Subject:	Radius of Influence Analysis for Injection IA-12 at the Phoenix-Goodyear Airport North (PGAN) Superfund, Goodyear, Arizona

Contract /TO: EP-S9-08-03 / TO # 0006 **ITSI DCN:** 07163.0005.0076

Innovative Technical Solutions, Inc. (ITSI), on behalf of the U.S. Environmental Protection Agency (EPA), has prepared this technical memorandum to evaluate the radius of influence for injection well IA-12 based on the data collected from the injection testing activities occurred at the well from August 17 to August 20, 2010.

The calculation showed that under ideal conditions the radius of influence for IA-12 is 798 ft at an injection rate of 250 gallons per minute (gpm) and 886 ft at an injection rate of 525 gpm. The actual radius of influence will be smaller. The information gathered from the limited injection data at IA-12 suggested that **three injection wells will be not enough to build an effective hydraulic barrier in the east plume boundary in the area North of I-10; more injection wells are warranted in this area.**

1. Introduction

Injection testing activities at IA-12 were started at a rate of approximately 250 gallons per minute (gpm) from 12:54 pm on August 17, 2010 to 8:26 am on August 18, 2010. From 11:12 am on August 19, 2010 to 9:19 am on August 20, 2010, the rate of injection was 525 gpm at IA-12.

Two piezometers, PZ-11and PZ-12, were used to monitor the groundwater levels related to this injection testing. The distances between PZ-11 and PZ-12 to injection well IA-12 are approximately 30 ft and 70 ft, respectively. Pressure transducers were installed at IA-12, PZ-11, PZ-12 and EPA MW-45A to record water levels at intervals of every 8 seconds during the testing phase. The water levels at these wells were also manually checked during the testing. Because there is no hydraulic response at EPA MW-45A, only data from PZ-11 and PZ-12 were analyzed in this evaluation. The initial water level at PZ-11 is 887.51 ft above mean sea level (amsl), and it is 887.09 ft amsl at PZ-12. The final water levels at the end of 250 gpm testing at PZ-11 and PZ-12 were 892.83 and 890.99 ft, respectively. At 525 gpm, the final water levels were 897.27 ft and 894.62 ft, respectively at PZ-11 and PZ-12.

2. Radius of Influence Analysis

The groundwater levels at both piezometers were stabilized well before the end of the testing activities; therefore, the water level data at these piezometers are used to estimate hydraulic conductivity using the steady-state Thiem Equation for unconfined aquifer. If it could be assumed that the area of one-foot rise is necessary to build an effective hydraulic barrier for an injection well, then the same Thiem equation is used to estimate the radius of influence for IA-12 at different injection rates (250 gpm and 525 gpm).

Thiem Equation:

$$K = \{Q/\pi(b_2^2-b_1^2)\} \times \ln(r_2/r_1)$$

where

Q is pumping rate (injection rate in this case)

K is hydraulic conductivity

b_1 and b_2 are saturated thickness at the different locations

r_1 and r_2 is the distance the center of the pumping (injection) well

The water levels from PZ-11 and PZ-12 at injection rate of 525 gpm were used to estimate the hydraulic conductivity. The saturated thickness in the area of IA-11 is estimated to be approximately 80 ft. At 525 gpm injection rate, the water level rise at PZ-11 is 9.8 ft (897.27 ft - 887.51 ft = 9.76 ft), and it is 7.5 ft at IA-12 (894.62 ft – 887.09 ft = 7.53 ft).

$$K = \{525 \text{ gpm}/3.14*((80-7.5)^2-(80-9.8)^2)\} \times \ln(70/30) = 83 \text{ ft/day}$$

Then, we could use the same equation to estimate the radius of influence (1-foot rise) for injection well IA-12.

Re-arrange the Thiem Equation, we have:

$$\ln(r_2/r_1) = \{(b_2^2-b_1^2)\pi K\}/Q$$

then, the radius of influence (r_2) then could be calculated.

(1)Injection rate of 250 gpm

At the end of 250 gpm injection testing, the water level rise at PZ-11 and PZ-12 is 5.3 ft and 3.9 ft respectively. PZ-12 water level is used in the calculation.

$$\ln(r_2/70) = \{[(80-1)^2-(80-3.9)^2]*3.14*83\}/250 \text{ gpm} = 2.44$$

r_2 = 798 ft radius of influence at PZ-12 with injection rate of 250 gpm

(2)Injection rate of 525 gpm

At the end of 525 gpm injection testing, the water level rise at PZ-11 and PZ-12 is 9.8 ft and 7.5 ft respectively. PZ-12 water level is used in the calculation.

$$\ln(r_2/70) = \{[(80-1)^2-(80-7.5)^2]*3.14*83\}/525 \text{ gpm} = 2.54$$

r_2 = 886 ft radius of influence at PZ-12 with injection rate of 525 gpm

Both these cases are assumed steady-state condition, and the calculated values are likely the maximum radius IA-12 could achieve under ideal condition. In reality, given the lower hydraulic conductivity at the nearby monitoring wells EPA MW-45A (21 ft/day), EPA MW-35A (8~31 ft/day), and EPA MW-39A (3~9 ft/day), the average hydraulic conductivity in the area of influence will likely less than the calculated value (83 ft/day) based on PZ-11 and PZ-12 data, therefore, the radius of influence of injection well IA-12 will be much smaller.

In addition, injection data showed that IA-11 has higher groundwater mounding than IA-12 (77 ft at IA-11 vs. 64 ft at IA-12 at same injection rate of 525 gpm), which likely suggests that IA-11 will have a smaller radius of influence than IA-12 based on the groundwater mounding at the wells.

The estimated distance between injection well IA-11 and proposed injection well IA-13 is approximately 2,900 ft; while it is approximately 2,600 ft between IA-13 and IA-12. Even the ideal maximum radius of influence is used for each injection well, there are still going to be significant gaps between the proposed injection wells IA-11 and IA-13, as well as between IA-13 and IA-12. **Three injection wells will be not enough to build an effective hydraulic barrier in the east plume boundary at the area north of I-10; more injection wells are warranted.**

3. Method Limitations

There are numerous assumptions and limitations associated with Thiem Equation. The applications of this equation to radius of influence estimation are limited by these assumptions. The results of the calculations should be evaluated carefully with these limitations in mind; nonetheless, it provides the valuable information and could provide useful guidance in planning and siting of future injection wells at the PGAN site.

Please contact Ailiang Gu (480-706-6488 ext 3400, agu@itsi.com) or Nancy Nesky (ext 3390, nnesky@itsi.com) with any questions about this technical memorandum.

Attachment VII

Innovative
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To:	Catherine Brown, RPM, EPA Region 9
From:	Ailiang Gu, PhD, RG, ITSI/Tempe Nancy Nesky, PE, ITSI/Tempe
Date:	October 13, 2010
Subject:	Evaluation of Injection Testing Data from Injection Wells IA-11 and IA-12, Phoenix-Goodyear Airport North (PGAN) Superfund, Goodyear, Arizona

Contract /TO: EP-S9-08-03 / TO # 0006 **ITSI DCN:** 07163.0005.0082

Innovative Technical Solutions, Inc. (ITSI), on behalf of the U.S. Environmental Protection Agency (EPA), has prepared this technical memorandum to evaluate the injection testing data associated with injection activities at wells IA-11 and IA-12. The injection testing data covers the time period from August 17, 2010 to October 1, 2010.

The data evaluation resulted in the following two observations:

(1) at injection well IA-11, only EPA MW-43A has shown impact of injection activities associated with IA-11, the water level variations at other monitoring wells (EPA MW-30A, EPA MW-34A, and EPA MW-55A) are more likely caused by other impacts other than injection at IA-11 and

(2) at injection well IA-12, only piezometers PZ-11 and PZ-12, and monitoring well EPA MW-45A have demonstrated the impact of injection at well IA-12, and field evidence could not support Crane Co.'s statement that EPA MW-39A has shown water level increase of 1 ft due to injection at IA-12. The radius of influence at IA-12 are in line with EPA's earlier assessment, which is 700-900 ft (1 ft of rise) for injection rates of 250 gpm and 525 gpm and approximately 1,100 ft (0.5 ft of rise) at the same injection rates (ITSI, 2010).

1. Introduction

Injection testing activities at IA-11 and IA-12 were initiated on August 17, 2010. A step-rate injection testing was performed from August 18 through August 20, 2010 using various injection rates. Each step generally lasts approximately 2 hours. Since August 20, 2010, 60 to 75% of treated water from extraction well EA-06 was delivered to IA-11for injection, and 25 to 40% was routed to IA-12 for re-injection. The total pumping rate from extraction well EA-06 is approximately 530 gpm during the time period of August 17 to October 1, 2010.

2. Data Evaluation

The monitoring wells associated with injection activities at IA-11 and IA-12 were evaluated to assess the mounding impact of the injections and radius of impact.

2.1 IA-11

The hand-measured water level data and transducer data from monitoring wells EPA MW-43A, EPA MW-30A, EPA MW-34A, and EPA MW-55A were evaluated to assess the impact of injection activities at well IA-11. In addition, monitoring wells likely outside the area of the influence from injection well IA-11 (EPA MW-18A, PZ-13, and EPA MW-16A) were also evaluated to obtain the background water level information.

The following table summarizes the hand-measured water level changes since the beginning of August 2010 for the above mentioned monitoring wells, and it also includes the water level information for the monitoring wells just before the start of step injection testing of 350 gpm at IA-11 on August 18, 2010 (units are in ft above mean sea level [amsl]):.

Date	EPA MW-43A	EPA MW-30A	EPA MW-34A	EPA MW-55A
8/4/2010	881.13	881.30	884.36 [a] (8/2/2010)	882.75 (8/3/2010)
8/17/2010	881.08	NA	881.28	NA
8/18/2010	882.12	NA	882.29	NA
10/1/2010	882.59	882.19	881.91	883.41
Water level change*	+1.46	+0.89	+0.83[b]	+0.66
	EPA MW-18A	EPA MW-16A	PZ-13	
8/4/2010	881.54 (8/3/2010)	NA	881.76	
8/27/2010	881.81	NA	NA	
9/20/2010	881.85	882.20 (9/22/2010)	882.33	
10/1/2010	881.78	882.13	881.97	
Water level change*	+0.24	-0.07[c]	+0.21	

Note: * Water level change since the beginning of August 2010;
a: data is not used in evaluation;
b: using 8/18/2010 water level as initial water level;
c: using 9/22/2010 water level as initial water level.

The transducer data are shown on Figure 1. The transducer data are in general agreement with hand-measured water level data at these monitoring wells. Figure 2 shows the hydrographs of monitoring wells which are expected be outside of the area of influence from injection well IA-11.

For monitoring well EPA MW-43A, it is highly likely that the water level rise at this well is partly due to injection activities at IA-11.

Groundwater level increase at well EPA MW-55A could not be as result of injection at well IA-11, as claimed by the Crane Co.'s Statement of Position paper. Since water level at EPA MW-55A is higher than those EPA MW-30A and EPA MW-43A, water has to flow uphill to reach well EPA MW-55A, which is impossible. The water level rise at well EPA MW-55A is likely due to regional water level variation. Similar water level variations could also be seen at background wells EPA MW-16A and PZ-11.

However, the water level rises at EPA MW-30A and EPA MW-34A could not be confirmed as the result of injection activities at well IA-11. The hydrographs at these two wells are different from well EPA MW-43A, and the synchronized water level variations at wells EPA MW-34A, EPA MW-30A, EPA MW-39A, and EPA MW-55A suggest the regional water level rise impact to these wells.

2.2 IA-12

The hand-measured water level data and transducer data from monitoring wells (and piezometers) PZ-11, PZ-12, EPA MW-45A, EPA MW-35A, and EPA MW-39A were evaluated to assess the impact of injection activities occurred at IA-12.

The following table summarizes the hand-measured water level change since the beginning of August 2010 for the above mentioned monitoring wells, and it also includes the water level information for the monitoring wells (PZ-11 and PZ-12) just before the start of step injection testing of 350 gpm on August 19, 2010 (units are in ft amsl):.

Date	PZ-11	PZ-12	EPA MW-45A	EPA MW-35A	EPA MW-39A
8/5/2010	887.73	887.74	886.24 (8/2/2010)	883.27 (8/4/2010)	884.81 (8/2/2010)
8/19/2010	889.81	889.70	886.40	883.43 (8/27/2010)	883.90 (885.26)
10/1/2010	892.59	892.54	888.53	883.66	885.03
Water level change*	+4.86	+4.80	+2.29	+0.39	+0.22

Note: * Water level change since the beginning of August 2010.

The transducer data are shown on Figure 3. The transducer data are in general agreement with hand-measured water level data at these monitoring wells.

It is reasonable to attribute the water level rises at PZ-11, PZ-12, and EPA MW-45A to injection activities at well IA-12, because (1) the close distances between these wells/piezometers and IA-12; and (2) the relationship between the hydrographs at these monitoring wells/piezometers and injection rates at IA-12. Water level variation (transducer data) at well EPA MW-35A is likely due to pumping at Suncor 3B, is probably not due to the injection activities at well IA-12, since the injection activities at well IA-12 cannot explain the cyclic pattern of water level variation at this well.

For EPA MW-39A, it is highly unlikely that the water level rise is due to the injection activities at IA-12. There are several facts to support the statement:

1. The calculated travel velocity and travel time do not support the argument;
2. Two water level measurements on August 19, 2010 had a difference of 1.36 ft (883.90 ft at 8:32 and 885.26 ft at 13:39)), it is not known which one is correct. Crane Co. team used 883.90 ft to demonstrate the water level rise of 1 ft at well EPA MW-39A, which EPA does not agree. If 885.26 ft were used, then the groundwater variation at this well would be more like background water level change.
3. The hydrograph of well EPA MW-39A is similar to wells EPA MW-34A, EPA MW-30A, EPA MW-55A, and PZ-13. As discussed earlier, water level changes at these wells could not attribute to injection activities.

The radius of influence at IA-12 are in line with EPA's earlier assessment, which is 700-900 ft (1 ft of rise) for injection rates of 250 gpm and 525 gpm and approximately 1,100 ft (0.5 ft of rise) at the same injection rates (ITSI, 2010).

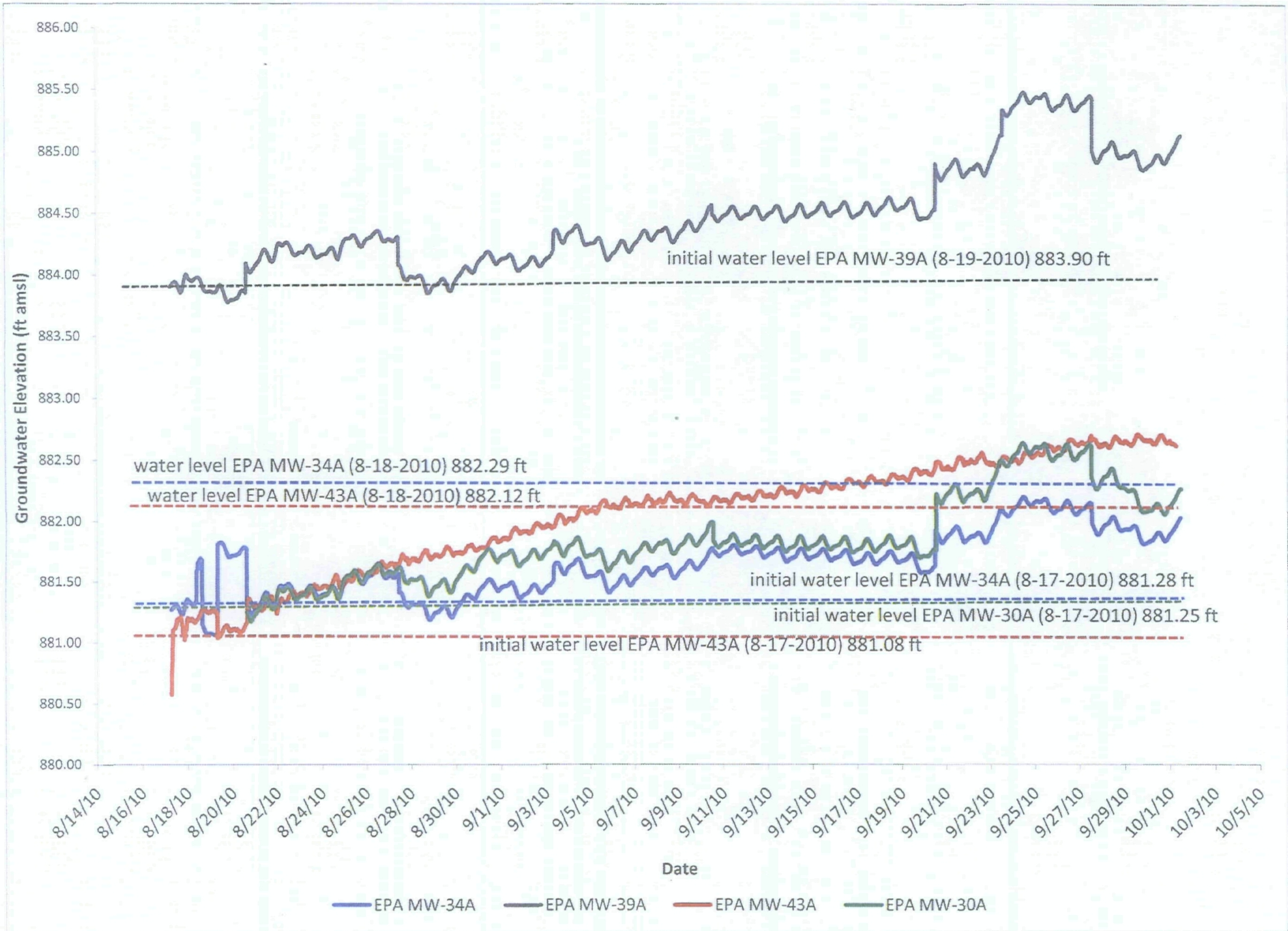
Please contact Ailiang Gu (480-706-6488 ext 3400, agu@itsi.com) or Nancy Nesky (ext 3390, nnesky@itsi.com) with any questions about this technical memorandum.

Attachments (3)

Figure 1 – Groundwater Hydrographs of Monitoring Wells in the Area of Injection Well IA-11
Figure 2 – Groundwater Hydrographs of Background Monitoring Wells
Figure 3 – Groundwater Hydrographs of Monitoring Wells in the Area of Injection Well IA-12

FIGURES

Figure 1: Groundwater Hydrographs of Monitoring Wells in Vicinity of Injection Well IA-11



13 Oct 2010

Figure 2: Hydrographs for Background Monitoring Wells

13 Oct 2010

Figure 3: Groundwater Hydrographs of Monitoring Wells in Vicinity of Injection Well IA-12

13 Oct 2010

Attachment VIII

TECHNICAL MEMORANDUM

CH2MHILL

Uncertainties in Future Consistency for Groundwater Flow Direction in the Northeast Plume, Phoenix-Goodyear Airport - North Superfund Site, Goodyear, Arizona"

PREPARED FOR:	Catherine Brown/EPA Region IX
PREPARED BY:	CH2M HILL/PHX
DATE:	August 23, 2010

This memorandum provides a technical analysis of groundwater flow as it relate to capture and containment of the TCE plume in the northeast portion of the PGA-North Superfund Site, Goodyear, Arizona. Crane Co. representatives have justified a lower number of injections wells along Dysart Road based on a northward shift in groundwater flow. Agency team representatives have questioned the consistency of the northern flow trend citing several uncertainties associated with data used in Crane's capture zone and mounding analyses.

This analysis focuses on the uncertainty associated with the recent northward trend in groundwater flow and how it may be affected by various forms of groundwater recharge. The most notable reason that a northward trend in groundwater flow appears to be associated with a large increase in water levels measured in Monitor well EPA-MW-45A (Figure 1).

The primary types of recharge to groundwater in this area are believed to be mountain front recharge and surface water ponding or drainage. Direct infiltration of precipitation is likely minimal in this locally arid environment. Mountain front recharge while significant is located some distance away and is not likely to affect an individual well in the manner that EPA-MW-45A has reacted. Figures 2 and 3 shows the local increases in water level elevation exceed six feet over the period of February to April 2010. Other monitor wells in the area do not show this magnitude of rise. Recharge associated with ponded water such as lakes, ponds and irrigation are likely to be consistent in the local area and no other unusual sources of ponding have been observed in the area. Therefore the rapid changes observed in EPA-MW-45A are not likely the result of ponded water. EPA-MW-45A is the closest monitor well to the surface water drainage of the Agua Fria River located approximated one mile to the east (Figure 1). The Agua Fria and its tributaries drain s a very large area and is a major tributary of the lower Salt River Valley.

Major tributaries to the Agua Fria include the main Agua Fria, Skunk Creek, Cave Creek and New River. Significant recharge in this normally dry drainage could affect local water levels. USGS stream gauging data for tributaries upstream of the PGA-North site for period of January thru May of 2010 show that a major stream flow event occurred in late January of

2010 (Figures 4a through 4c). In fact this flood event was one of the largest for several decades (Figures 5a through 5c). Local observers have indicated that flow in the river near McDowell Road filled the floodplain at flood stage and lesser flows were sustained for more than a month.

It must be concluded that this flood event in the Agua Fria is likely the primary cause of the increased water levels observed in EPA-MW-45A. If that is the case, then the northern shift in groundwater flow may also be a result of this ephemeral event. It should also be concluded that this trend may reverse itself during normal dry periods where little recharge occurs in the Agua Fria River. Since the Crane Co. capture zones and mounding analyses are based a northward flow there appears to be greater uncertainty of maintaining the plume capture on a consistent basis. This is particularly true with only two injection wells located along Dysart Road. The potential for large gaps in the mounding created by an insufficient injection well network is significant and should be avoided by adding additional injection locations. Additional injection locations will add greater certainty of capture and provide operational flexibility. With a higher number of injection locations the injection water can be quickly reallocated to optimize capture of the plume based on whatever scenario develops with future shifts in groundwater flow direction.

If you have any questions or comments regarding this memorandum, please contact our office at (480) 966-8188.

Cc: File

Figure 1 - PGA North Drainage and MW-45A Location

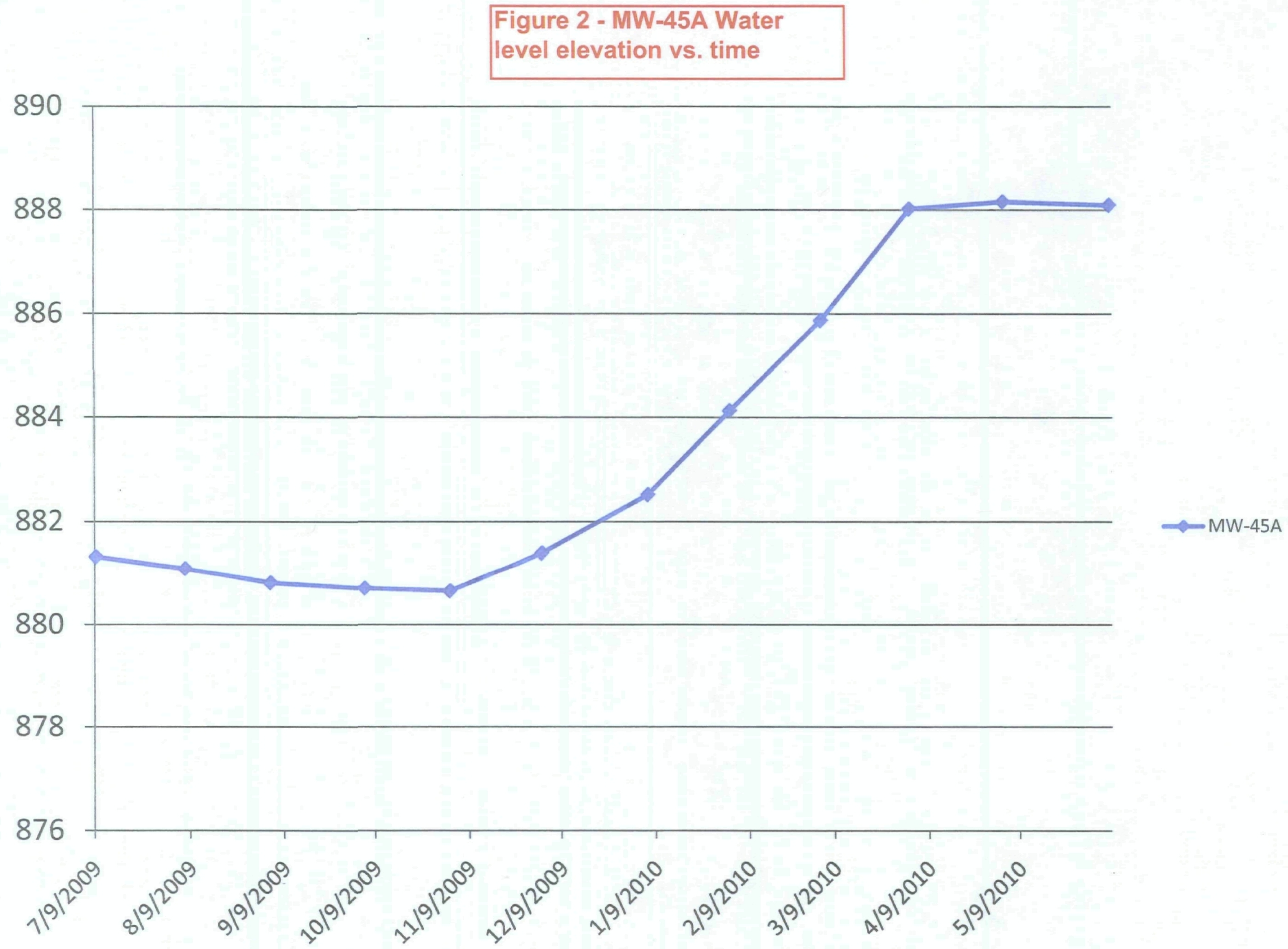
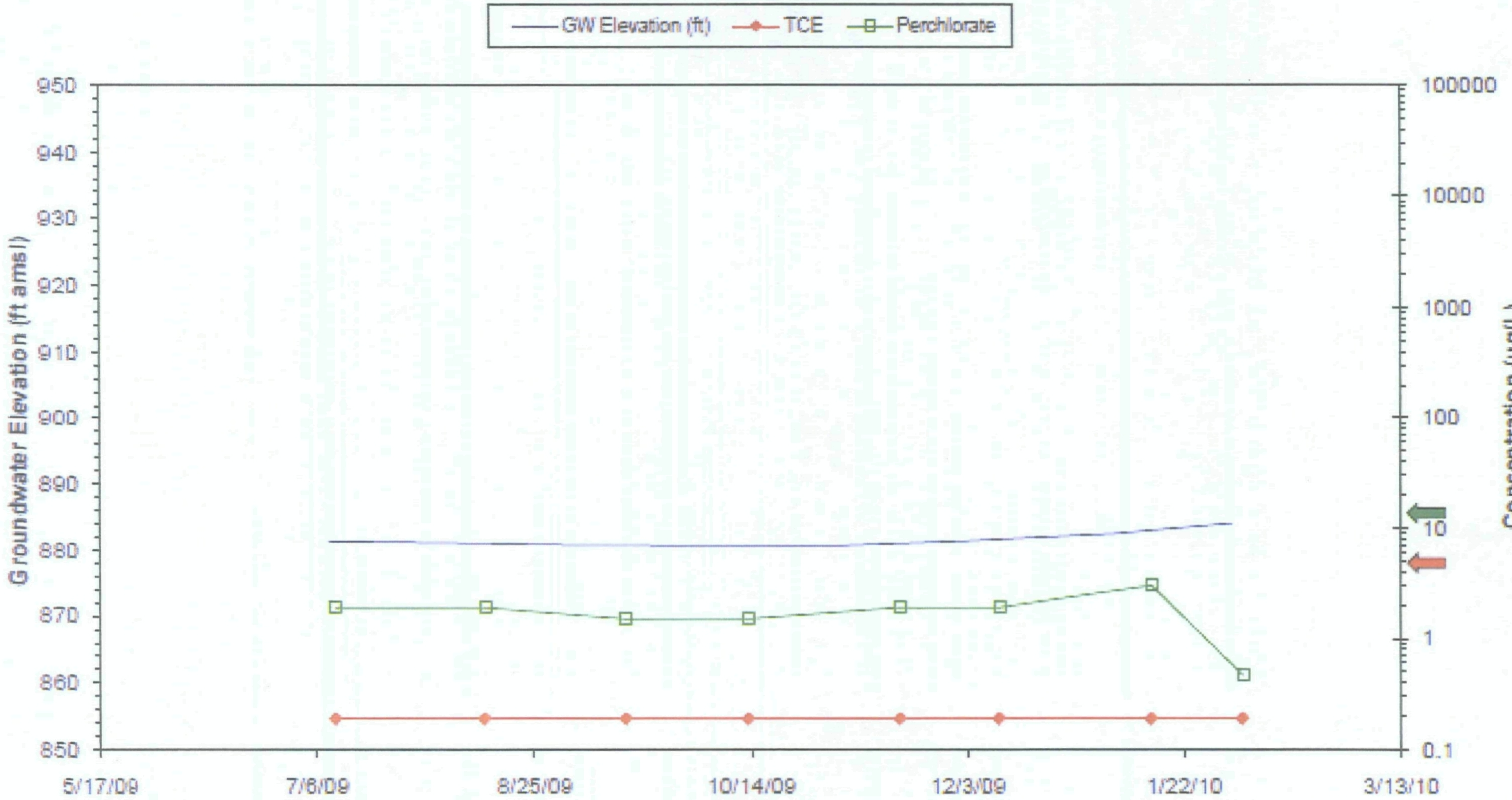


Figure 2 - MW-45A Water level elevation vs. time
890
888
886
884
882
880
878
876
7/9/2009
8/9/2009
9/9/2009
10/9/2009
11/9/2009
12/9/2009
1/9/2010
2/9/2010
3/9/2010
4/9/2010
5/9/2010
MW-45A

Figure 3

EPA MW-45A
Trend Analysis of TCE and Perchlorate Compared to GW Elevation
Phoenix-Goodyear Airport-North Superfund Site
Goodyear Arizona



amsl: above mean sea level
ug/L: micrograms per liter

Site Specific Cleanup Goal (14 ug/L)
Federal Maximum Contaminant Level (5 ug/L)

Figure - 4a

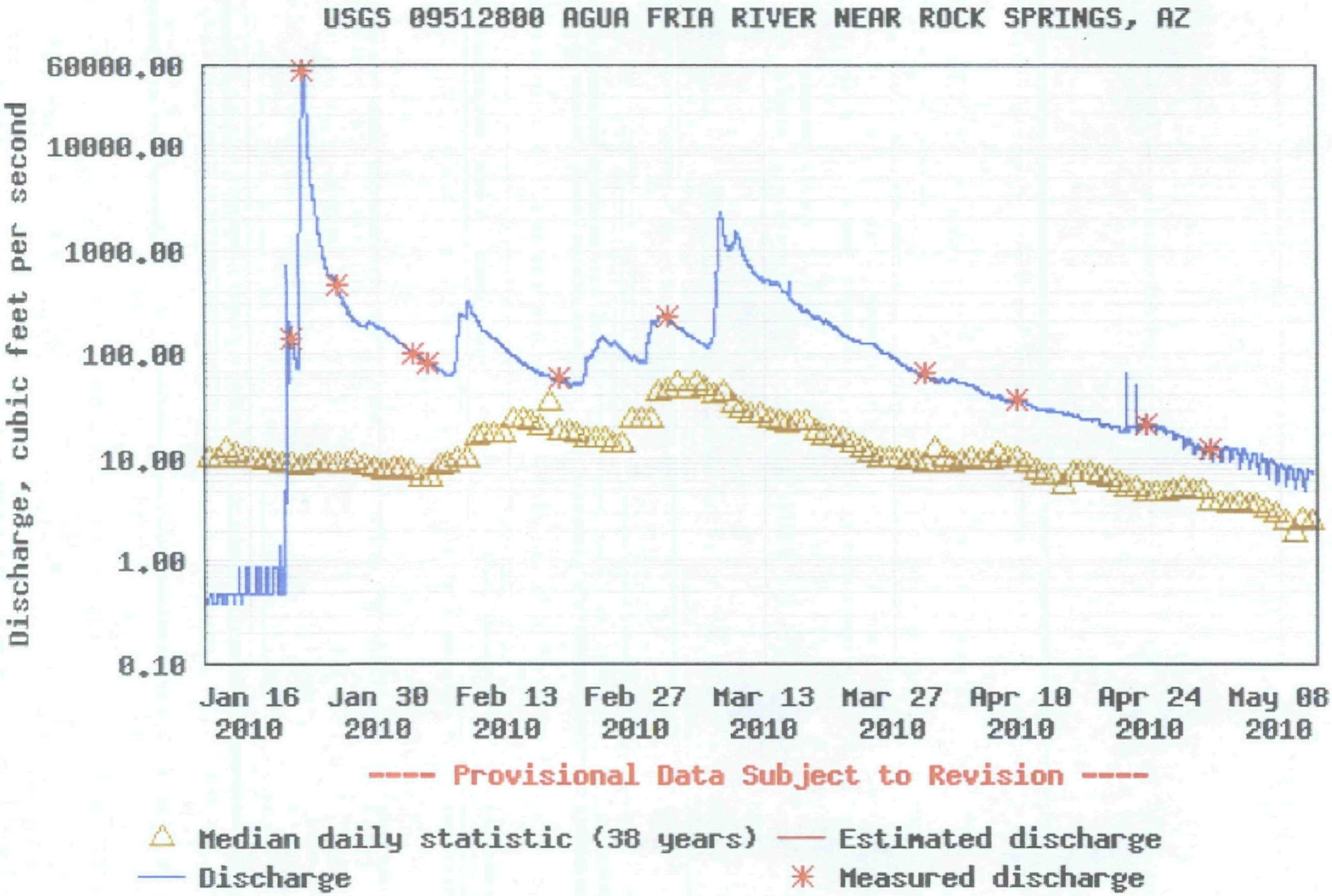
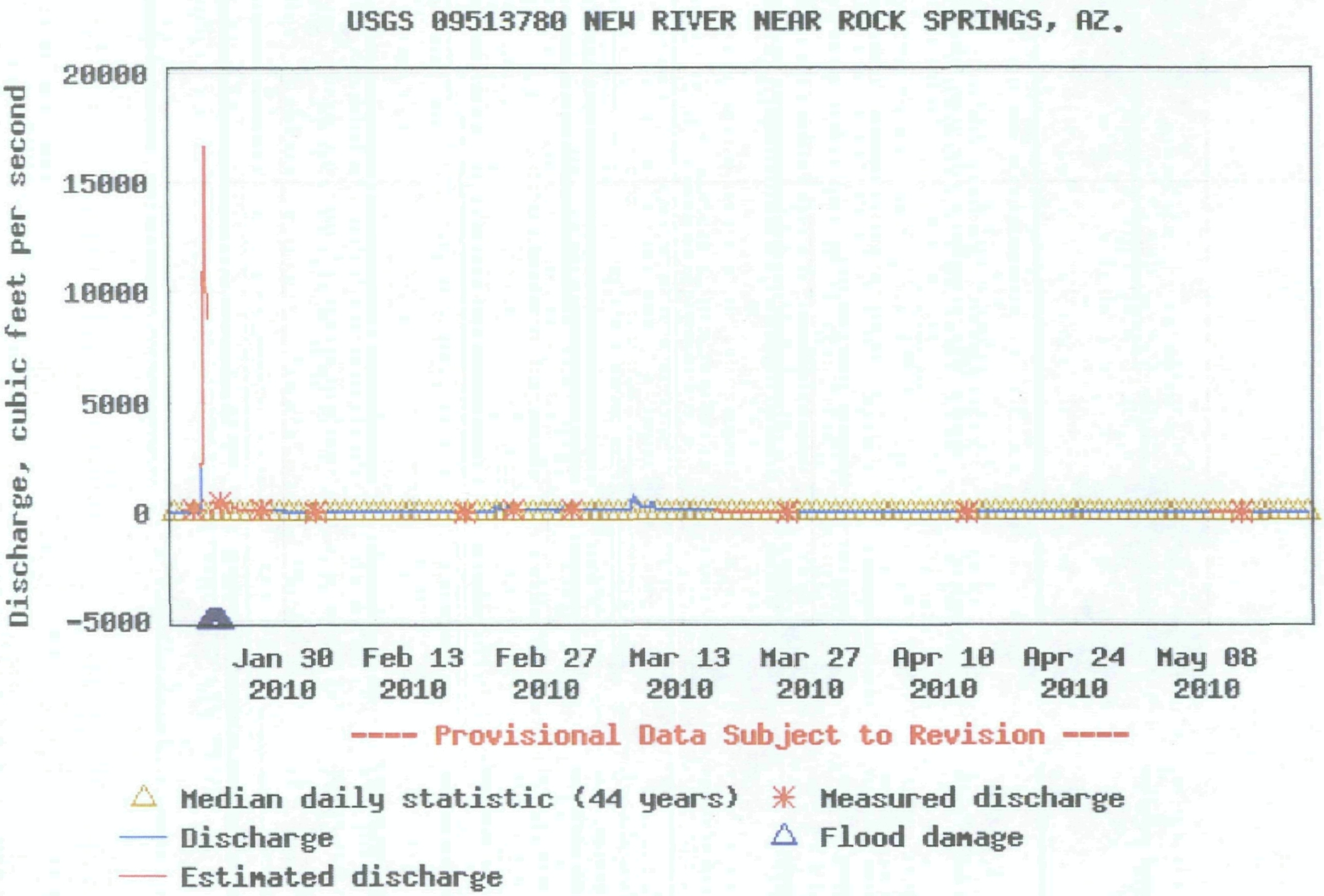

USGS 09512800 AGUA FRIA RIVER NEAR ROCK SPRINGS, AZ
60000.00
10000.00
1000.00
100.00
10.00
1.00
0.10
Discharge, cubic feet per second
Jan 16 2010
Jan 30 2010
Feb 13 2010
Feb 27 2010
Mar 13 2010
Mar 27 2010
Apr 10 2010
Apr 24 2010
May 08 2010
---- Provisional Data Subject to Revision ----
Median daily statistic (38 years)
Estimated discharge
Discharge
Measured discharge

Figure - 4b



USGS 09513780 NEW RIVER NEAR ROCK SPRINGS, AZ.
Discharge, cubic feet per second
20000
15000
10000
5000
0
-5000
Jan 30 2010
Feb 13 2010
Feb 27 2010
Mar 13 2010
Mar 27 2010
Apr 10 2010
Apr 24 2010
May 08 2010
---- Provisional Data Subject to Revision ----
Median daily statistic (44 years)
Measured discharge
Discharge
Flood damage
Estimated discharge

Figure - 4c

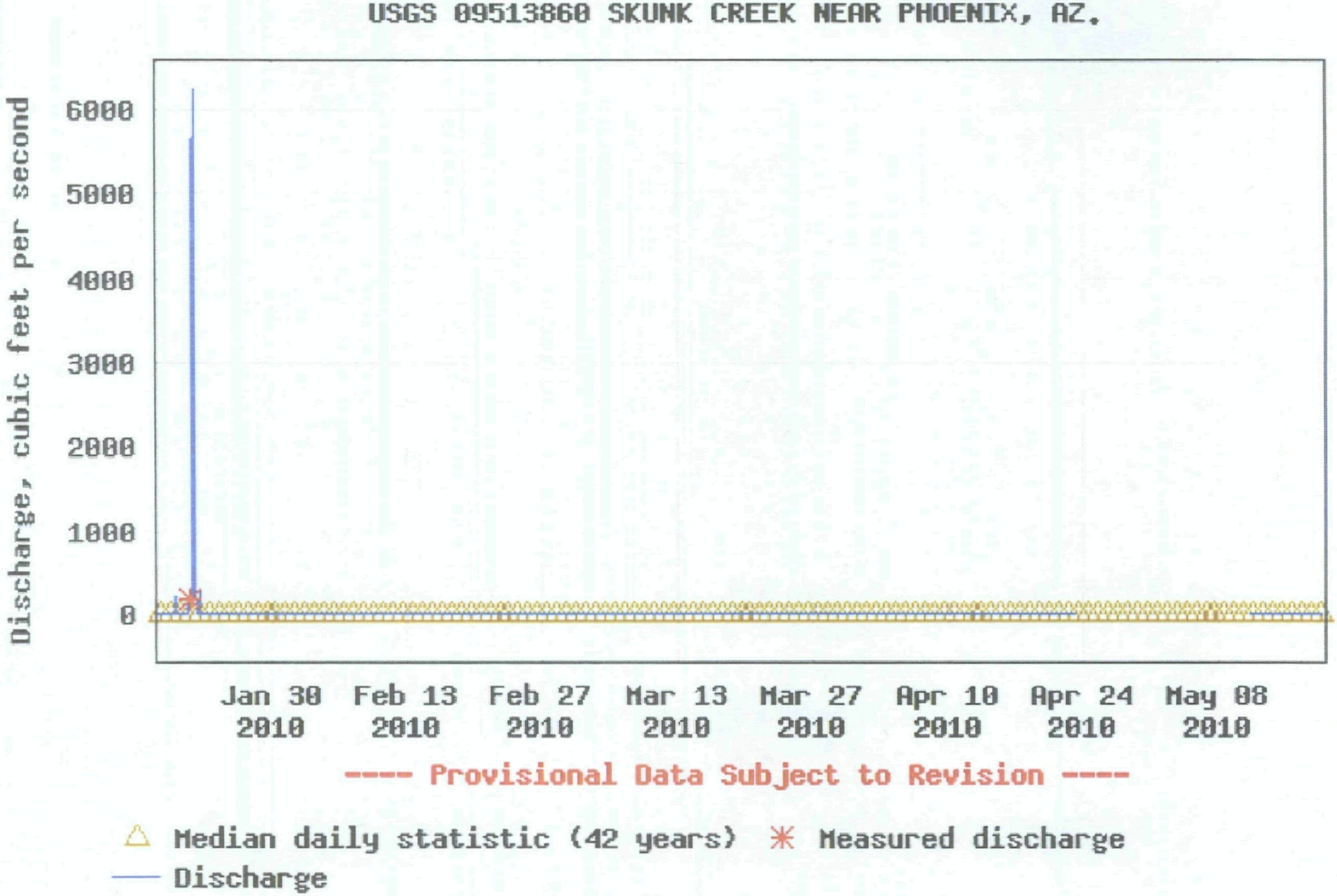
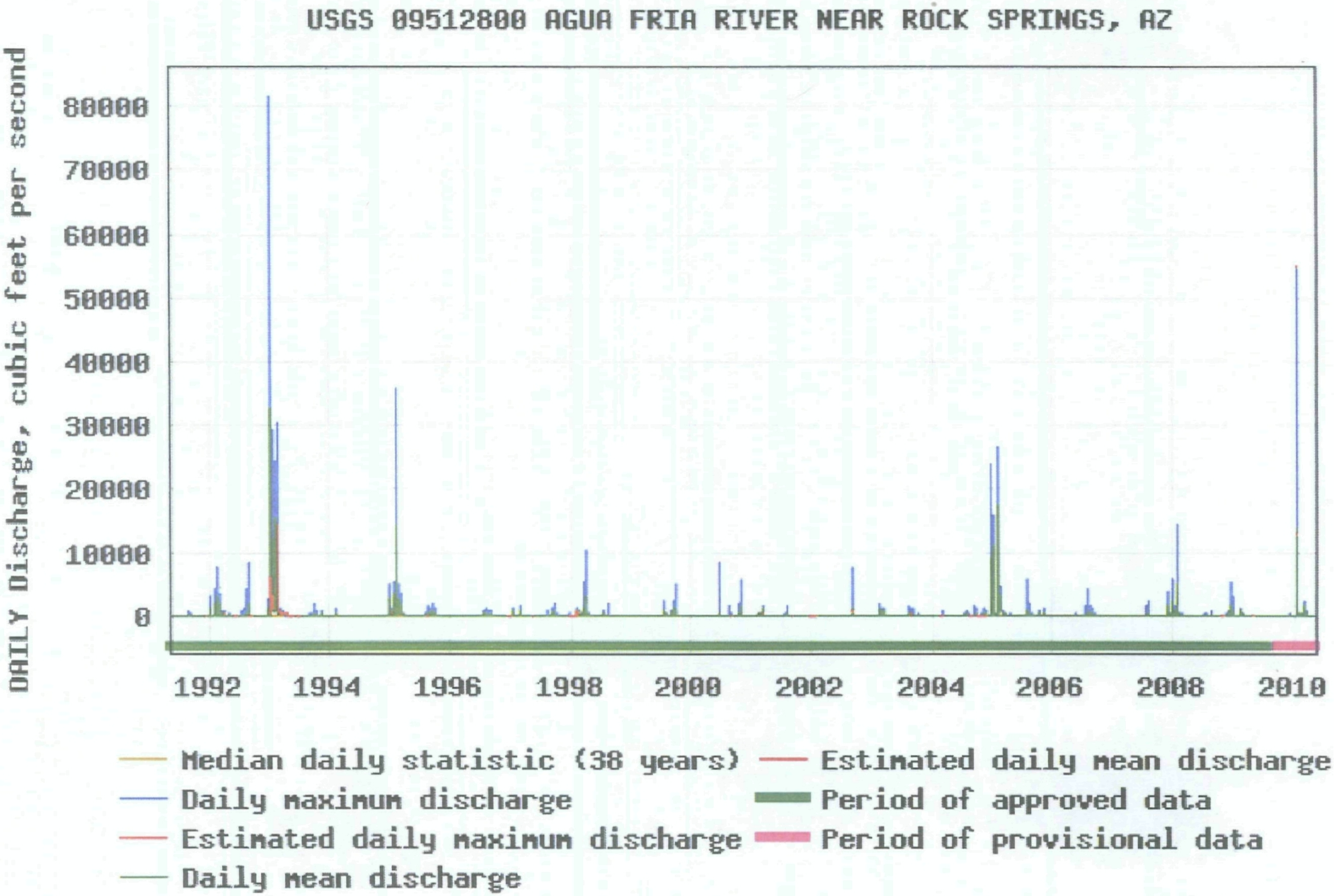

USGS 09513860 SKUNK CREEK NEAR PHOENIX, AZ.
Discharge, cubic feet per second
6000
5000
4000
3000
2000
1000
0
Jan 30 2010
Feb 13 2010
Feb 27 2010
Mar 13 2010
Mar 27 2010
Apr 10 2010
Apr 24 2010
May 08 2010
---- Provisional Data Subject to Revision ----
Median daily statistic (42 years)
Measured discharge
Discharge

Figure 5a



USGS 09512800 AGUA FRIA RIVER NEAR ROCK SPRINGS, AZ
DAILY Discharge, cubic feet per second
80000
70000
60000
50000
40000
30000
20000
10000
0
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Median daily statistic (38 years)
Daily maximum discharge
Estimated daily maximum discharge
Daily mean discharge
Estimated daily mean discharge
Period of approved data
Period of provisional data

Figure 5b

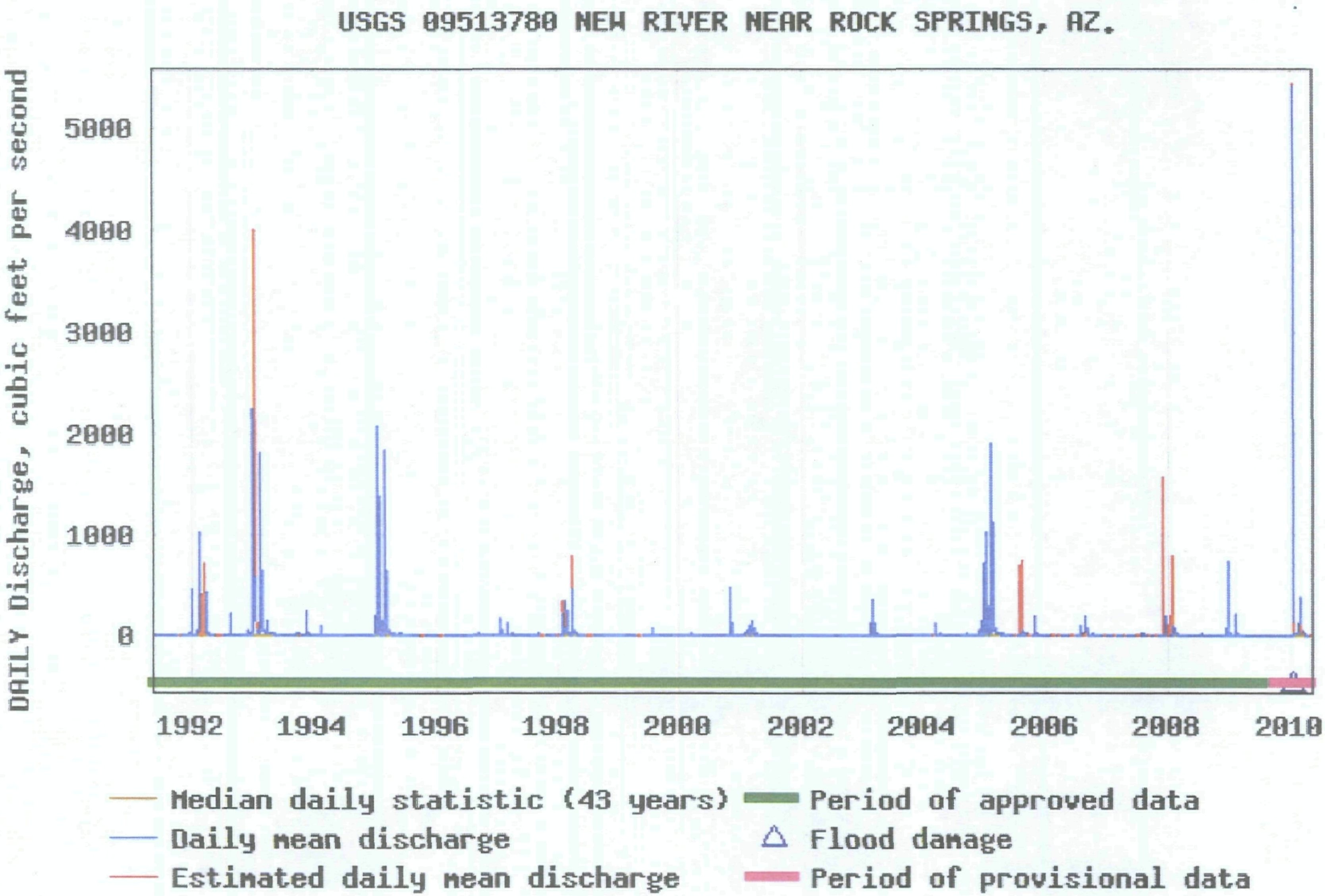
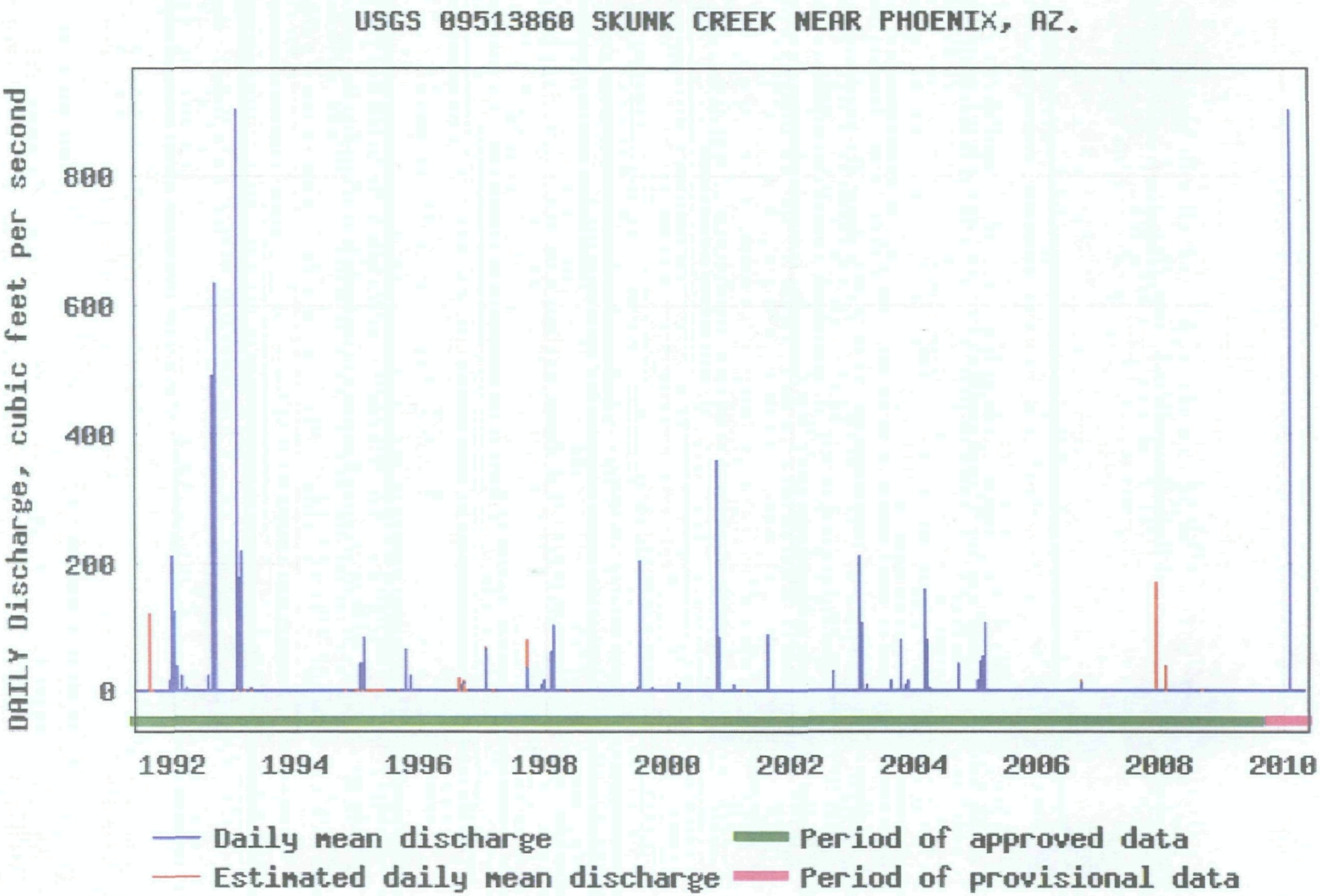

USGS 09513780 NEW RIVER NEAR ROCK SPRINGS, AZ.
DAILY Discharge, cubic feet per second
5000
4000
3000
2000
1000
0
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Median daily statistic (43 years)
Daily mean discharge
Estimated daily mean discharge
Period of approved data
Flood damage
Period of provisional data

Figure 5c


USGS 09513860 SKUNK CREEK NEAR PHOENIX, AZ.
DAILY Discharge, cubic feet per second
800
600
400
200
0
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Daily mean discharge
Estimated daily mean discharge
Period of approved data
Period of provisional data